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TELEPHONE ENGINEER

VOLUME 27 JUNE, 1923 Number 6

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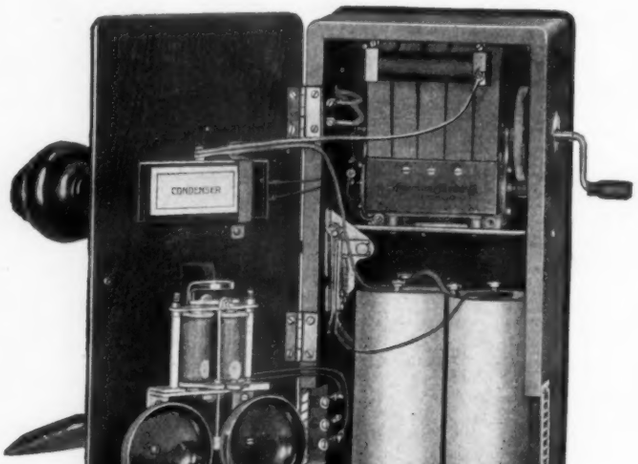

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Waste in Plant Operation

Attention to Many Little Details Where Loss May Occur May Result in Substantial Operating Economies. Education of Workmen and Their Supervisors Suggested as a Remedy

By R. V. ACHATZ

If you have a knack for reciting proverbs or wise saws, just try to see how many you know that express in some fashion or other that many little things make a great thing. The purpose of this article is not to rehearse all of the ancient sayings of this kind but it is hoped that it will point out many of the possible little leaks that may allow the telephone dollars to flow away into expense which should be left as profit, after operating costs have been paid.

We do not think there are many big leaks in the telephone business. Public regulation and limited income have prevented this but, from time to time, we have observed places where small savings could be made that would amount to considerable sums in the course of a year. In a business operated on as close a margin as the telephone business, these savings are of some importance.

In a previous article (TELEPHONE ENGINEER, March, 1923) were discussed some of the things that might be done to keep down excessive cost of construction so the present article will deal principally with things affecting the operation and maintenance of the plant. Some factors which may affect depreciation will also be mentioned as depreciation is, in the long run, an element of operating cost.

Elimination of Waste a Necessity

"Eliminate Waste" is one of the present day slogans of industry and, under the leadership of the able Secretary of Commerce in President Harding's cabinet, much progress in that direction has been made in some of the industries. Elimination of waste means elimination of waste not only of material but of human effort, and both factors enter into the problem.

Waste of material means, not only loss and breakage but the use of more material than is necessary and the loss through failure to obtain the full life of material. It may be due to the use of more expensive material when cheaper material is available or it may be occasioned by the use of cheaper material which becomes worn out, inadequate or obsolete, in the place of better grades which cost less in the long run. Careful study and foresight are necessary to select just the right kind and amount of material for the work, and good management is necessary that full use of the material be obtained.

R. V. Achatz, head of the Telephone Engineering Course at Purdue University

Waste of human effort occurs when greater exertion is required and greater fatigue experienced than the minimum that is necessary for the work at hand. It may occur through duplication of effort, or it may be due to idleness, when proper planning would keep the worker comfortably busy. The best utilization of human effort requires a careful study of working methods and planning of working time so that the desired result may be achieved in the shortest practicable time that is consistent with the safety and well-being of the worker.

With these things in mind, we may come to a consideration of some of the specific instances where waste may occur in the operation of the telephone plant.

Pole Line Material May Be Used More Economically

Only three or four days before this was written, we were in a pole yard of a small company where half a carload of cedar poles were scattered around on the ground in a weed-grown lot. Decay had already commenced on the under side of some of the poles and it is probable that the entire lot is deteriorating as fast as if they had been set into the line when the shipment was received. Here is a waste of costly material because a little time was not spent in piling the poles on skids.

Some time ago, we drove along a section of line of a telegraph company where we knew that a gang had worked a year or more before. We counted not less than twenty cross arms that had been hauled out when the work was going on and never had been picked up and hauled in after the work was completed.

We have seen fine, butt-treated poles start to decay because careless linemen had punctured the treated layer with their spurs when climbing. We have seen others where the treatment was made useless because the poles were dragged along the ground instead of being carried. We have seen junction and terminal poles cut to pieces by the climbers of linemen because steps were not provided. We have, all, known of poles that were taken out of service and left to rot away by the road side when they were in good enough condition to reset as a shorter pole or to leave in the line, reinforced by a stub.

Avoidable Losses in Cable and Wire Plant

The aerial wire and cable plants also have furnished their share of loss. Can anyone tell us how many coils of wire have become tangled and have found a final resting place behind a convenient clump of bushes along the way? What has become of the short ends of line and drop wires? Have they been salvaged and worked up into tie wires, if iron or weatherproof; or returned as scrap, if copper and too short to use? How many insulators and wood brackets have been made to serve as missiles to be thrown at barking dogs?

In the cable plant, the opportunities for loss are even more numerous than in the aerial wire plant. Ends of cable and messenger are cut too long at splices and terminals, making excessive waste in terminating or splicing. Subsidiary cables and legs to terminals are not properly arranged on the pole, and suffer damage from men climbing. Splices are not properly supported and cracks develop at the end of the joint. Terminal studs in the cable terminals are twisted off, because eight-inch pliers are used, rather than the proper type of terminal nut wrench. Underground cables serve as ladders for men entering and leaving the manholes. The list might be continued at great length.

Equipment May Also Be an Offender

The outside plant is not chargeable for all of the loss of material that occurs. The equipment, both substation and central office, contributes its quota of preventable loss. There is, always, some waste of installation material, and other waste occurs in the operation of the equipment. Telephones are located in dark corners where the breakage of receivers and mouthpieces is great. Desk stands are located near windows where cords get wet and have to be replaced. Inside wire is run in locations where it is likely to get wet or be damaged.

In the central office, supervision of the work of those who install and maintain the equipment is, naturally, more close and, while the opportunities of loss are reduced, here also are many places in which loss may occur. In one office, it was found that the wire chief was accustomed to start the mercury arc rectifier when he came in the morning and continue operating it at the normal charging rate until he left in the evening. The result was that the batteries were gassing violently most of the time, wasting much energy and greatly reducing the life of the plates.

In another office, during a shortage of switchboard cords, it was found that the switchboard repairman had continued to order cords and plugs and had hidden away more than enough cords to replace every cord and plug in the board with a new one. Here was an investment of several hundred dollars lying idle, to say nothing of the inconvenience at other offices of the same company where the supply of cords was inadequate. In still another office, the switchboard repairman disliked the job of cutting back cords so, whenever a cord became frayed, it was replaced by a new one.

One company was unfortunate in having in its employ a repairman whose ability to diagnose a case of trouble was limited to the more simple and common faults. If anything out of the ordinary run of trouble appeared, he began changing parts. Usually in the process, the trouble was cleared, although he could not always tell how it happened. The worst feature of his method was that he was suspicious of the part he had removed and he proceeded to break it so that it was not possible to use it again. Many perfectly good keys, relays, lamps, etc., thus found their way into the scrap heap and much damage was done to the switchboard forms and cables. Other cases might be cited, but these will serve to illustrate some of the ways in which loss may occur in the central office.

Duplication of Effort Is Loss

Loss of time and effort usually accompany loss of material or use of material. We have all heard the oft quoted lines about the man who can make two blades of grass grow where one grew before. Perhaps some day someone will be found to say something about the repairman who makes but one case of trouble come in where two came in before. Waste of effort usually comes from doing twice what should only have to be done once or making two trips for what might well be done in one.

We once knew a lineman who was proud to claim that he never shook out a cross twice in the same place. He never was too busy to untie the wire for a couple of poles on each side of a break so that the slack could be evened up not only in the spans where the break occurred but in the spans adjacent.

It takes little additional time and effort to make a complete inspection of a telephone and its installation when the repairman goes on a case of trouble and many potential cases are cleared in the process. Some really remarkable reductions in the number of cases of trouble have been made where this practice has been put into force.

Other Opportunities to Reduce Waste

There are many other opportunities for stopping leaks than those mentioned, but space and time will prevent mention of more than a few. The use of tools frequently is accompanied by wholly avoidable loss and breakage. Transportation equipment also may be subject to waste. One company, in its company magazine, published reports on the miles per gallon of gasoline obtained from its Ford cars. They ranged in individual cases from 8 to over 20 miles per gallon. Evidently, some of its cars are being operated much more economically than others. A little investigation, undoubtedly, would disclose the reasons. The waste due to avoidable accidents to workmen always is worthy of attention.

Some Suggested Remedies

Having pointed out many possible sources of waste, it may be expected that some suggestions should be offered as to means of preventing them. The two great causes of waste, of the kinds named, are lack of care and lack of knowledge. Workmen and their superiors must be educated in the use of proper methods and in the exercise of proper care. Many companies have found it to be of advantage to advise, by placards posted in warehouses and shops, the cost of various items, and have found the men to be much more careful when they understand the value of the things that they are using in their daily work.

Perhaps most of us are thinking that we are not suffering losses of this kind in our plants, but are we sure? A little investigation will not take much time and some real savings may be made if just a few of the leaks are found and stopped.

Sold to Pay Federal Tax

Iroquois, S. D., reports that the property of the Beadle County Farmers' Mutual Telephone Co. has been sold at auction to satisfy a $700 claim of the government for unpaid taxes, a representative of the Internal Revenue office at Aberdeen conducting the sale. The property sold included 46 miles of line, switchboard, and a frame building. This is the first time in the history of the South Dakota Internal Revenue office, it is said, that it has been found necessary to enforce a claim of this character. Maybe South Dakota will learn something from this lesson and allow its telephone companies adequate rates in the future.

New Tennessee Corporation

The Buntin Farm Mutual Telephone Lines have been incorporated at Portland, Sumner county, Tenn., by W. E. Freedle, Mario Caudill, N. E. Armstrong, David Potts and Robert Harris.

Everyday Telephone Helps

Second of a Series of Articles for Beginners; for Students, Small Plant Managers, Rural Line Owners and Others — Receiver, Transmitter, and Condenser Principles and Troubles

By P. Kerr Higgins

The Telephone Receiver

The following explanation of the operation of a telephone receiver may be helpful in giving the reader an idea of how a telephone operates:

P. Kerr Higgins

The telephone receiver may be defined as an acoustic radiator. The reproducing part is a diaphragm of thin, soft iron about 5.5 centimeters in diameter and from .02 to .05 centimeters thick, having a natural frequency of about 1000 cycles. When one speaks into the transmitter at the other end of a line the action which takes place is that the voice striking the transmitter impresses upon the line a series of electrical waves resembling in shape an amplitude the voice waves which have actuated or excited the transmitter. In passing from the line, these waves travel along connecting wires to the coils at the end of the receiver. These waves ebbing and flowing over the receiver alternately increase and decrease the magnetism through the core (or pole pieces), and the diaphragm, being situated directly in front of these pieces and being in a magnetic field, vibrates in unison with the incoming currents (or voice waves) from the transmitter.

This changing magnetic field thus exercises a varying pull on the diaphragm, causing it to vibrate to and fro. The movement of the diaphragm sets the air in front of the opening of the receiver in motion, thus producing at the receiving end sound waves similar to those absorbed by the transmitter. To increase the sensitiveness of the receiver for special work, current amplifiers are usually necessary, as in the loud speaker, wireless practice, etc. The distance of the diaphragm from the pole pieces is extremely important, as is also the thickness and uniformity of the diaphragm, and most of the receiver troubles are found to be due to carelessness in this regard, combined with injured diaphragms and badly fitting shells and caps.

Telephone Receiver Troubles

Receiver troubles are very few and are usually due to poor adjustment between the permanent magnet and the diaphragm, giving the receiver a hollow sound when too far away from the magnet and a distant faint sound when too close to the magnet. The lead-in wires from the binding posts to the coils sometimes get broken, unsoldered or the insulation worn off, in the first two cases producing an open circuit and in the latter a short circuit. To test a receiver, a simple method is to connect the doubtful receiver to a good telephone receiver cord (or wires) and fasten one of the receiver cords (or wire) to the battery and attach the other at intervals, noting the sound in the receiver under test and comparing the same with a good or new receiver and adjusting accordingly. In the case of an open circuit, no click will be heard on closing the battery, and in the case of a short circuit a loud click will be heard in the good receiver. Another frequent cause of trouble is due to demagnetization of the permanent magneto. The test for magnetization is that the permanent magneto should support the diaphragm hanging by its edge. The symptom of demagnetization is hearing very weak (distant).

As in all telephone equipment, a resin joint is very liable to cause an intermittent trouble.

Always test a receiver for trouble disconnected from the instrument. If a cord is necessary, be sure to use a good one. One of the largest manufacturers of receivers has not yet learned how to eliminate "freezing" of the diaphragm to the magnet and is the only standard make in the market showing a large percentage of this trouble. Attention is drawn to this to prove how very essential it is to have the proper spacing between the permanent magnet and the diaphragm, and also the right amount of magnetism and suitable quality of iron, together with proper fitting of shell and cap. Receivers with badly fitting caps and shells are a source of expense and annoyance.

The Transmitter

Two transmitters are in common use today, namely, the local and common battery transmitter, and the only fundamental difference between them is in the resistance of the transmitter button or electrode. In the case of the common battery, the resistance is made high so as to work economically on the higher voltage used, and this is done by using finer granules; for example, those which would pass through a 100 or 110-inch mesh sieve. The common battery transmitter usually averages about 100 ohms (the unit of resistance measurement), while in the local battery it has a normal resistance of about 20 ohms. They may be interchangeable, but do not give good results. However, the local battery transmitter can be used by changing the button or refilling it with the proper size of granular carbon, so that it will work on common battery lines. It is important that the button be of the proper size and the distance from the diaphragm should be correct. This adjustment, however, is not recommended except under manufacturing conditions. The carbon for local battery transmitters is screened through a sieve 60 meshes to the inch. All the carbon which passes through is rejected. The size of the carbon used by different manufacturers is not always the same for the same service, and this accounts for a large variation in the efficiency of transmitters, and this is one of the sore spots in telephone transmission, as we do not always get even the same efficiency from the transmitters manufactured by the same manufacturer. It is sincerely hoped that the future may develop some standard manufacture along these lines, as in practice it has been a puzzling question to the telephone owner.

The talking current, while not alternating in character, is a varying current, but alternating in effect, and has the same properties with respect to the retardation of the coils, the talking current being different when used with and without an induction coil.

Transmitter Troubles

Transmitter troubles are usually due to broken wires, loose connections or crossed wires in the transmitter, and when not due to this cause are in the carbon button and may be due to the granules being burned or packed. As previously stated, the writer advises

making no effort to replace or adjust carbon in the button when this is necessary, preferring to recommend that the carbon button or the transmitter complete be returned to the manufacturer for adjustment or repair.

The transmitter is perhaps the most sensitive part of a telephone, and some manufacturers, knowing this and not caring to have their name on transmitters which in reality are not theirs (as the carbon used in recharging is often not their standard), have sealed up the carbon button and replace them for a nominal charge. The writer believes this is a splendid plan and advocates its adoption by others. The transmitter is the heart of telephone transmission. Enough said.

One of the causes of burned carbon is due to using too much battery on the transmitter. If it will not work well with two good cells and the batteries are not too far away from the transmitter and leading-in wires are not too small, better send to manufacturer for inspection and repair. Don't experiment—it does not pay.

Induction Coil

At first only the receivers were used, then a battery was connected in series, then a receiver, transmitter and battery in series, usually one wire only being used, but sometimes two. The writer connected up his first metallic line in a cotton mill on John street, Glasgow, Scotland, about the year 1882 or 1883, and it consisted of two very large receivers with battery in series, connecting the cotton mill office with the mill, a distance of about one thousand feet. The receivers were used for both transmission and receiving and gave what we considered good results at that time. Fig. 1 shows connection used. A small push-button was used to open and close the talking circuit, and a vibrating bell was used for signaling. The inconvenience of using the receiver for both talking and hearing developed the idea of a separate transmitter. Again the series method was used, as shown in Fig. 2, but the varying length of the line and consequently the varying resistance in the external circuit gave varying results and thus forced the development and introduction of the induction coil.

The transmitter and receiver have already been described. In discussing the action of the receiver, we observed that the sound waves caused by the movement of vocal sounds spoken into a telephone transmitter at one station are changed by that transmitter into electrical waves which travel over the connecting wires to the other station, pass through the telephone receiver and are turned back again into sound waves approximately similar to those produced at the transmitting end. We noticed further that the sound waves developed at the transmitting end caused the transmitter diaphragm to vibrate, thus varying the pressure between the granules of carbon in the transmitter. The amount of current flowing through the transmitter button will depend upon the resistance which the carbon granules offer to its passage. This varies according to the pressure between the granules, which continually changes with the vibration of the diaphragm fastened to the carbon button. This being true, it follows that the current flowing through this resistance will change continually with the vibrations of the diaphragm. When the transmitting circuit is closed and a normal condition exists (such as no one speaking into the transmitter at either end), then the current flowing will be normal or constant and the amount flowing in the circuit will depend upon the combined resistance of all the parts of the circuit. Hence, if the stations are very far apart, as is usually the case, the high resistance of this circuit will reduce the current flowing and consequently weaken the talking efficiency of the circuit. It is therefore seen that the resistance of the external transmitting circuit is very important, and we must therefore furnish a transforming circuit which will transmit the variations to the line without increasing or varying the resistance in the original transmitting circuit. In other words, the induction coil was devised and introduced as a means of keeping the resistance of the line wire from controlling the amount of current supplied to the transmitters. The induction coil usually consists of a wooden spool, its form and shape being familiar to most telephone men. In the center of the spool and running its entire length is an iron wire core fitted into a paper tube, provided with wooden heads (or ends) so arranged as to hold the windings of copper wire forming two distinct circuits, known as the primary and secondary circuit, the former being wound directly on the paper tube, while the secondary winding is wound over the primary winding. In each winding the wire ends are left protruding through the wooden ends so as to be available for connecting purposes. The primary (or local circuit) consists of the battery, primary winding of the induction coil, receiver hook connections, and the transmitter. Such a circuit is shown in Fig. 3. The circuit is opened and closed by the action of the receiver hook, being closed when the receiver is off the hook and opened when the receiver is hung up, this action being necessary to save battery consumption. It is obvious that such an arrangement as this localizes the transmission circuit and prevents the length of the line from varying the resistance in same. The action of the coil

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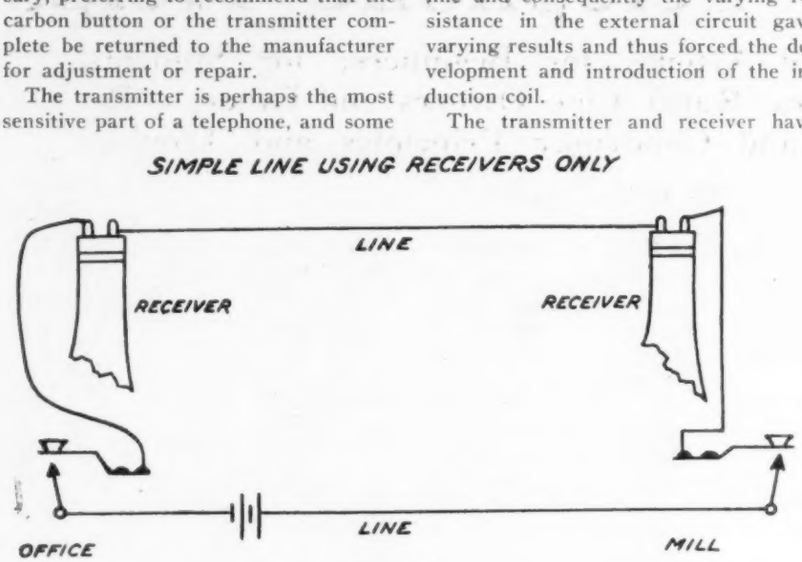
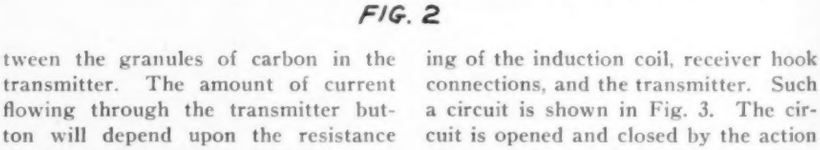


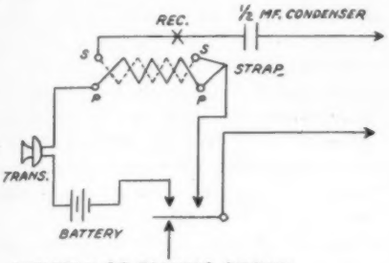
FIG. 1



SIMPLE CIRCUIT TRANSMITTER, BATTERY & RECEIVER IN SERIES

FIG. 2

may be briefly described as follows: The current from the battery passes through the primary winding, magnetizes the iron wire core, creating a field of magnetic force which surrounds the entire coil. So long as the current strength remains uniform or stationary the lines of force around the coil will remain constant, and hence no effect or change would take place in the sec-



SKELETON OF TALKING CIRCUIT

FIG. 3

ondary winding. If, however, the strength of the current in the primary circuit is varied in any way, a corresponding change would occur in the lines of force surrounding the coil. Such a change sets up or creates an electrical pressure in the secondary winding which causes current to flow in the secondary circuit when this circuit is closed, as, for example, when it is connected up with a receiver, a line or other external circuit. It is readily seen that variations of the transmitter diaphragm, causing variations of resistance in the transmitter button, sets up continual changes of current flowing through the primary circuit. As these variations continue corresponding changes take place in the magnetic field surrounding the coil, which in turn develop electrical pressure in the secondary circuit. This electrical pressure sends current waves out over the line to the distant station, where they in turn pass through the secondary winding of the coil and receiver. When these current waves pass through the receiver the diaphragm vibrates in harmony with them, thereby reproducing the voice sounds spoken into the transmitting station. Low wound coils (that is in the secondary coil) are best suited for direct lines having one or less than ten stations thereon, while for party lines having ten or more stations a higher wound coil gives much better results. The reason for this is that with low wound coils it is difficult to ring the subscriber wanted while several people have their receivers off the hook and are listening in on the line.

The following are some of the dimensions of some of the good coils now in use in local battery telephones. It may be noted that color of wire used should be different for primary and secondary:

(1) "This coil consists of 400 turns of No. 26 B&S, single silk covered wire measuring 1.62 ohms for the primary. The secondary consists of 1,820 turns of No. 28 single cotton covered wire measuring 22 ohms. The core is composed of No. 28 BWG iron wires carefully annealed and one-fourth inch in diameter; total length of spool three and three-fourths inches; heads one inch square; length of winding space three inches."

(2) "This coil is wound on similar annealed iron wire core three-eighths of an inch in diameter, head one and one-fourth inch square; primary, four hundred turns of No. 24 B&S single cotton covered wire, 1.6 ohms resistance; secondary, two thousand turns No. 30 B&S single cotton covered wire measuring forty ohms; length of winding space, one and one-half inches."

(3) "For a very small coil the following is a very good design: Diameter of annealed wire core, one-fourth inch; heads, three-fourths inch square; length winding space, two inches; primary, three hundred and fifty turns No. 24 single silk covered wire, .9 ohms; secondary, two thousand turns No. 33 single silk covered wire, 90 ohms resistance. In this coil the secondary is a little high in resistance. Should the primary be wound with No. 26 wire and the secondary with No. 32, a better proportion would be reached."

Current when furnished direct to the transmitter is of large volume and small intensity, but when used in connection with an induction coil is transformed and sent out of small volume and large intensity.

The Condenser

The practice of "rubbering," so common on rural lines, caused by subscribers taking down their receivers to get the latest gossip, necessitated the development of something to prevent the reduction of current in passing through the receiver windings. The use of high wound secondary circuits in the induction coils have been a great help in this matter, but the use of a condenser has become very popular. A ½ m. f. condenser placed in series with the receiver circuit of bridged magneto telephone insures that the ringers on party lines will be operated by the low frequency current from a hand generator. If this is not used, the current from a hand generator is usually dissipated in the low windings of the receivers which may be off the hook, and therefore the stations where the receivers remain on the hook will not be rung. In common battery practice the condenser is used in the ringer circuit of a subscriber's telephone to prevent the escape of the direct current (furnished from the central office) through the ringer coils. The use of the condenser in the primary or transmitting circuit is impossible, as the purpose and use of the condenser is to obstruct the passage of direct current. However, high frequency alternating currents pass through a condenser with little loss.

The capacity of the condenser is its ability to accumulate electricity under a given electrical pressure, and hence is governed by the proximity of its plates, their dimensions and the specific inductive capacity of the dielectric. It is claimed that the static capacity of a telephone line depends upon the length and cross-section of the wire and its proximity to the ground. Therefore, to construct equipment capable of accumulating comparative static charges the conducting surfaces must be large, the space between them small and the dielectric used of high inductive capacity. When such an arrangement is connected across a battery the plates connected with the positive pole of the battery become positively charged and those connected with the negative pole become negative.

A typical condenser consists of alternate layers of tinfoil and specially prepared paper saturated with paraffin, and so arranged as to expose a large surface to inductive action without taking up too much space. The alternate foils are connected in parallel to form the two poles of the condenser. Condensers may be connected up in combinations very similar to that of batteries—that is, similar poles are connected together in parallel when quantity of current and not increased voltage is desired. When condensers are so connected, then the joint capacity is equal to the sum of the capacity of all the condensers thus connected. If desired to connect in series (as when unlike poles of a battery are connected together) then the capacity of the condensers is the reciprocal of the sum of the reciprocals of the several capacities (as will be explained later). A combination of these methods gives us a wide variety in capacities. The unit of capacity is known as the micro-farad, but it is abbreviated to mf. The charge accumulated in a condenser of given capacity is increased by an increase of pressure. Hence the actual capacity of a condenser is independent of variations and pressure, but the static charge is proportional to the difference of potential between the two sets of plates and is found by multiplying the pressure by the capacity. Electro motive force (voltage) multiplied by the capacity is equal to the charge. A condenser is said to have a capacity of one farad if under pressure of one volt (unit of pressure) it accumulates one coulomb (unit of quantity) of electricity. Electricity

under pressure in a condenser is cumulative, acting as it does much in the same way as a compressible gas.

In practice the farad is found to be too large a unit for convenience, hence the micro-farad is used, which is one million times less than the farad, and so a condenser of one micro-farad capacity would accumulate the one millionth part of a coulomb, which is the electrical unit of quantity and which equals quantity of electricity delivered by current of one ampere flowing for one second.

All the plates on one side of the dielectric are joined together by a metal conductor and the other end to terminal, the other set of plates being connected up to the other terminal in a similar manner.

Condensers when connected in parallel have a joint capacity equal to the sum of their respective capacities. For example, if three condensers, each having a capacity of three micro-farads, are connected in parallel, then their joint capacity is nine micro-farads, because the area of the opposing plates is now three times greater than in one condenser alone. When condensers are connected in series their joint capacity follows the law of joint resistance, being equal to the product of their respective capacities divided by their sum. Hence the joint resistance law applies. For example, it is desired to connect four condensers having capacities of 8, 4 and 2 mf. each.

To find the joint capacity we write three fractions with 1 for the numerator and the capacity of the three condensers respectively as the denominators and add them:

$$\frac{1}{8} + \frac{1}{4} + \frac{1}{2} = \frac{1}{8} + \frac{2}{8} + \frac{4}{8} = \frac{7}{8}$$

Now, if we divide 1 by the sum we get the joint capacity:

$$\frac{1}{\frac{7}{8}} = \frac{8}{7} = 1.14 \text{ micro-farads}$$

Condenser Troubles

It is apparent that condensers connected in series have a capacity less than the condensers singly. It is, however, very seldom necessary in telephone practice to connect condensers in series with each other except for testing purposes. Nevertheless, it is convenient frequently to connect them in parallel, as will be seen later.

It has been noted that condensers allow alternating currents to pass through them, but obstruct the passage of direct current. Alternating currents do not always fluctuate at the same rate of speed, some alternating ten times per second, while others may change ten thousand times a second. This rate of change is known as "frequency," and the lower the frequency of an alternating current the more closely it resembles direct current. Hence, the condenser offers a much easier path to high frequency than low frequency currents, and it is this characteristic which makes it valuable for use on heavy rural lines. The writer does not recommend rural lines exceeding ten stations, but knows of many places where there are rural lines with thirty or more subscribers connected, and in such cases the use of condensers in the receiver circuit is imperative. The use of a condenser is also convenient should one of these parties forget to hang up his receiver. Since the talking current has considerably higher frequency than the ringing current, the use of condensers does not affect transmission to any great extent.

Condensers are also used in common battery systems in series with the telephone operator's receiver, first, to prevent direct current from flowing through the receiver and, second, when the operator is talking to or listening the listening key connects her receiver and condenser across the line. As in common battery work, there is direct current always on the line, and this would flow through the receiver under such conditions and affect the magnetism of the receiver were it not for the condenser, either by over-strengthening the magnet, causing the diaphragm to clamp against the pole pieces or weaken the permanent magnet and reduce the vibrations. In addition to these the sharp click (caused by the opening and closing of the battery) by the key is avoided. The condenser is also used in series with the primary of the operator's induction coil in common battery work. In such a circuit the battery for the operator's transmitter goes through a retardation coil (which will be described later), the transmitter and the primary of the induction coil back to the battery. The condenser being connected across the primary of the induction coil forms an easy path for the high frequency talking current without causing a perceptible loss of direct current. The talking current (produced in the operator's transmitter) flows in the closed circuit, including transmitter, induction coil primary and condenser. The energy supplying this talking current comes from the condenser, which charges and discharges very rapidly and thus absorbing the changes in current caused by the variations in the resistance of the operator's transmitter.

The condenser used in a subscriber's set in a common battery telephone not only keeps direct current from flowing through the ringer when the receiver is on the hook, but also acts as a booster, the primary of the induction coil and the transmitter being directly connected to the line, while the secondary of the induction coil is connected through the receiver, transmitter and condenser.

There are many other uses in which the condenser proves useful, and it may be necessary to discuss these at a later date.

A brief description of the construction of a typical condenser may prove interesting. "The paper used as a dielectric is dried slowly by exposure to currents of warm air and covered with tin. Two strips of the foiled paper, interleaved with two strips of plain paper, are rolled up and immersed in melted paraffin wax, the number of turns depending upon the capacity required. The strips of paper are usually four inches wide by a half millimeter thick, and the foil paper three and one-half inches wide by one and one-quarter millimeters thick. The connecting strips are of annealed copper foil, slipped into place between the foiled surface and the inter-leaving paper. They should make contact with the foiled surface over practically its full width, protruding about one inch. They should be placed at the middle of the foiled strips. The rolls are placed in a hermetically sealed metal case. It is necessary to see that the paper has been carefully covered with the foil, so that the insulation resistance and capacity may be correct. After completion the necessary tests are made by the manufacturer both for insulation and electrification."

Induction Coil Troubles

Induction coil troubles are covered usually under three heads: First, open

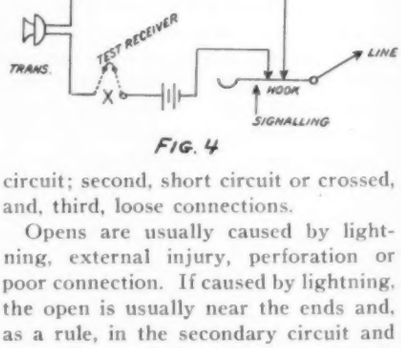


FIG. 4

circuit; second, short circuit or crossed, and, third, loose connections.

Opens are usually caused by lightning, external injury, perforation or poor connection. If caused by lightning, the open is usually near the ends and, as a rule, in the secondary circuit and frequently near the iron core, and can often be easily found and repaired; if not the coil must be rewound. All connections must be tight and preferably soldered. If open in the primary coil the transmitter will seem dead, but you can hear the distant station. If open in the secondary the instrument seems completely dead. To test an open

primary coil, it is necessary to open the battery circuit on one side, as shown in Fig. 4, and insert a receiver in series with the circuit. If the primary circuit is O. K., the transmitter will come up in good shape, while if open the circuit will be dead and no click heard in the receiver when making connection. In making this test it is necessary that the receiver hook be up so as to close the primary circuit. To test the secondary coil, place one or two cells of battery across the line terminals and connect a good receiver across the secondary punchings of the coil. Fig. 5 shows this connection. If the secondary coil is open, a distinct click will be heard in the test receiver. If, however, the coil is good, either no sound will be heard or a very faint click. Be careful in making this test to see that the regular receiver is off

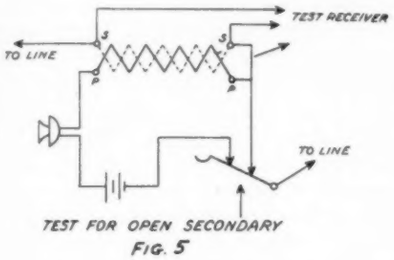


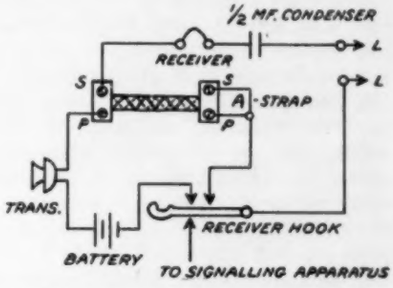
FIG. 5

the hook and properly connected up. It is also necessary to know that the regular receiver is good; otherwise, it is best to short-circuit or strap the receiver punchings while testing the coil. In this test it is necessary to know that the wiring in the secondary circuit is all in good shape and you are only testing the coil; otherwise, you must insert the receiver in series with the secondary circuit and run down the open, testing each part of the circuit separately. This is also true when testing the primary circuit. In other words the above tests are given, assuming that the balance of the circuit is O. K. and that you are only testing the coil to save taking it out of the instrument.

A careful study of these circuits is necessary in order to intelligently locate trouble; hence, it is well to remember that the primary circuit consists of the battery, transmitter, primary coil and hook connections, and when the receiver is off the hook the primary circuit is closed and current is flowing around the primary circuit from the battery. In the secondary circuit the receiver, secondary coil, hook connections and line are in series, and when this circuit is closed by the action of the hook and having a line connected to the instrument, the induced circuit is traveling over that circuit when variations in the current flowing in the primary circuit take place, as already described. Theoretically, the primary and secondary are isolated from each other, but in practice one side of the primary is strapped to the secondary side, as shown in Fig. 4. Always remember that there may be two cases of trouble existing in a telephone at the same time, and this is liable to throw off the inexperienced in making tests. It must also be remembered that there are two types of magneto telephones, namely, the Series (which is now or should be obsolete) and the Bridging, which is best for all purposes. In this, as in all other testing, each unit or part of a circuit should be tested separately if the trouble is not known. For example, if the trouble has been diagnosed as being in the primary circuit, then test separately the battery, transmitter and primary of the induction coil; also examine the switch hook contacts and see that they are clean and making proper contact. If these are found to be in good shape, then the trouble must be in the wiring, which can be located by connecting up a good receiver in series with the primary circuit, taking a piece of good wire and using it as a jumper to test the various sections of the primary circuit wiring, the same method being used in testing the other sections of the instrument.

Condenser Troubles

Condenser troubles are of two kinds —open and short circuits. When the circuit is open the trouble will usually be found on the condenser punchings, being due to an open wire or a badly soldered connection. It may also be due to a broken strap inside of the condenser. Short circuits are usually caused by a perforation of the leadfoil inside of the condenser and can be usually burned out by connecting up with an electric light circuit, using the 110-volt or secondary circuit of same. In making this repair care must be taken to flash the connection rather than to hold it on permanently, and as a means of safety it is well to cut in series with the condenser and the electric light circuit a 25-watt lamp. When the condenser it used in series with the receiver in bridging telephones on party lines, the writer has frequently found condensers short circuited without the fact having been discovered until complaints were made that subscribers were not receiving the signals from other telephones on the same line or from central office. When such a complaint therefore is made, one of the first things to do is to test out the condensers. In common battery work when a condenser becomes shorted the signal in the central office is permanently lighted and it is necessary to plug out the line in trouble until same has been removed. In most condensers after being in use some time there is more or less of a leak, and the extent of this leak determines its usefulness. For this reason it is customary to test condensers with a volt meter, connecting up several cells of dry battery in series with the condenser to be tested and the volt meter, and noting the result with the condenser in and out



LOCAL BATTERY TALKING CIRCUIT
A. STRAP ON TALKING CIRCUIT
FIG. 6

of the circuit. A first-class condenser will show practically no deflection on the volt meter scale.

Concerning Repairs

Spare transmitters, receivers, coils, condensers, etc., should be in the trouble man's kit for replacement purposes, as it is seldom practical to make repairs at the substation unless forced to do so, when a memo should be made and defective unit replaced as promptly as possible.

Leich Electric Company Increases Sales Force

Genoa, Ill.—The Leich Electric Co. now is represented in Kentucky and Tennessee by Claude Prueitt. Mr. Prueitt is well acquainted with the local conditions in this territory, is well versed in telephone equipment, and will be of valuable assistance to the operating companies in recommending the type of equipment that will provide the best service under the conditions it will operate. In addition to telephone apparatus, Mr. Prueitt will introduce the Radd Spark Plug, Leich Magnetic Timer and radio specialties, including the Non-Tune radio rectifier. Traveling will be by car, so all telephone companies, no matter how small or where located, will receive proper attention.

Oscar Eanes, 35 Years with C.&P., Gets Diamond Emblem

Danville, Va.—Oscar Eanes, for 35 years an employee of the Chesapeake & Potomac Telephone Co., and now manager here, has been given a diamond-studded pin in appreciation of his long service with the C. & P.

Practical Plant Problems

Chapter XV—Joint Use of Poles by Telephone and Electric Light Cos.

By Charles W. McKay, Associate Editor*

There are a number of reasons why the joint use of poles by telephone and electric light companies has become well nigh imperative, under certain conditions. In the first place, and speaking from the standpoint of the public, we are far more particular about the appearance of our streets than we were, formerly. Comparatively, but a few years ago, almost anything in the way of overhead cable and wire distribution would "get by." In fact, many municipalities seemed to concur in the idea that a conglomerate mass of electric light, telephone and trolley poles on the main thoroughfares was indicative of prosperity. Now, however, times have changed, and even the smaller cities and towns incur appreciable expenditures for ornamental street lighting fixtures, while unsightly telephone or electric light distribution is absolutely taboo.

Again, speaking from the standpoint of the telephone and electric light companies themselves, economy is a factor of prime importance. Obviously, it is far cheaper to erect a substantial pole line that will fulfill the joint requirements of telephone and electric light companies than to build and maintain separate pole lines.

If pole lines are used jointly, however, it is most important that adequate provision shall be made to protect the interests of both companies as well as that of the public. A good many years ago, the American Telephone & Telegraph Co., in conjunction with prominent electric lighting and power interests, evolved a set of joint use specifications. These specifications, or suitable modifications thereof, now are in use by nearly all telephone and electric light companies.

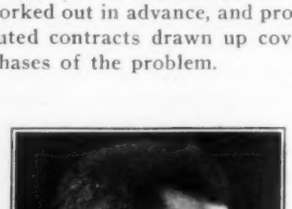
There are three effective ways of solving the joint use problem:

1. The expense of installation and maintenance may be shared by the telephone and electric light companies.

2. The poles may be installed and owned by the electric light company and a suitable schedule of rentals evolved, under the terms of which the telephone company can make use of these poles.

3. The poles may be installed and owned by the telephone company, the telephone company sub-letting space to the electric light company.

Regardless of the plan adopted, it is most important that all of the details, with respect to joint occupancy, shall be worked out in advance, and properly executed contracts drawn up covering all phases of the problem.



Chas. W. McKay, Asso. Edtr.

The contract, or agreement, for the joint use of poles by telephone and electric light companies, should specify the relative positions of all cables, wires and auxiliary equipment belonging to each of the contracting parties. In connection with the foregoing, it is most important that every possible provision shall be made to insure the safety of the employees of both companies, when working on poles, and to insure the safety of pedestrians, in case they should come in contact with poles, anchors or guys.

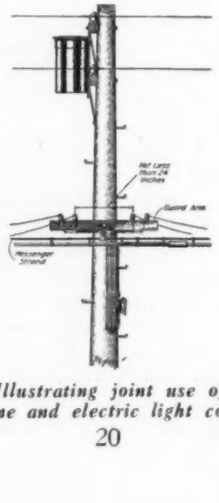


Fig. 1—Illustrating joint use of pole by telephone and electric light companies

The electric light or power wires usually are placed near the top of jointly-used poles. This for the reason that eletric wires and cables are, as a rule, mechanically stronger, and therefore less likely to break, than the telephone wires; also, due to the fact that, generally speaking, the telephone company must have access to its interests more often than the electric light company.

If possible, there should be a clearance of six feet between the lowest electric light cross arm and the uppermost telephone cross arm, in cases where the open wire mode of distribution is adhered to by both companies. The clearance should never be less than four feet, under any circumstances. To facilitate work of the electric light companies' linemen, a "climbing space" should be provided between the telephone wires nearest the poles. If this space is not less than 24 inches, the electric light linemen can pass between the wires with very little risk of disturbing or injuring the interests of the telephone company.

In cases where the telephone company uses the aerial cable mode of distribution, the clearance between the interests of the telephone company and the interests of the electric light company may be reduced to four feet, providing a wooden guard arm is placed on the pole, immediately over the messenger strand to which the cable is attached. With such a guard arm installed, the electric light linemen can make use of it for a "foothold," thus eliminating danger to the workmen from coming in contact with the metal, cable-supporting strand; also, obviating the possibility of damaging the telephone company's property. In Fig. 1, an illustration is presented of a jointly-used pole, equipped with a telephone cable, a guard arm, electric light wires and an electric light circuit transformer.

A more detailed discussion of the joint-use problem will be presented in a subsequent installment of this series.

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Radio Frequency Currents

A Simple Explanation in Language the Telephone Man Can Understand of the Action of Electric Circuits at Alternating Current Frequencies Used in Radio

By R. T. Cloud

If you throw a pebble into a pond of water and watch the successive waves travel outward you will get a good idea of how radio waves are transmitted through space. The radio waves, however, are not confined to the surface but travel in all directions like giant hemispheres of ever increasing diameter.

As far as can be determined the only difference between these waves and light waves are the number of vibrations or alternations per second. The useful radio frequency waves at the present time being from 10,000 to 2,000,000 per second and probably being capable of extension up to 20,000,000 per second. Light waves cover a frequency range of from 3,000,000,000,000 to 3,000,000,000,000,000 per second. Both types of waves travel through space at the same rate of speed, i. e. approximately 190,000 miles per second.

The principles of production and transmission of these waves are the electrical principles governing alternating currents with which telephone men are more or less familiar. It may be well however to review briefly the principal underlying features of the theory of such currents.

Alternating current theory is based on the assumption of a current that follows the sine law or a simple harmonic motion. A pendulum is a good example of such a motion. We may call the position zero where the pendulum would hang if at rest and motion to the right positive and to the left negative. Starting at zero and swinging to the right the pendulum swings to its farthest point positive then recedes again to zero passing through zero to negative motion to maximum position then recedes to zero position thus completing the cycle. You will note that the pendulum bob is at its maximum velocity while it is passing through the zero position and at maximum positive and negative swing the motion slows down, stops and reverses.

We can now draw a curve of the motion by plotting time along the horizontal plane and distance traveled by the pendulum on the vertical plane. Positive swing is above the horizontal line and negative below the line. We obtain a curve as shown in Fig. 1.

This form of curve can be obtained from a circle by laying out 180 degrees along the horizontal plane and the sine of the angles corresponding on the vertical plane. This curve is used in alternating current calculations not because all alternating currents follow the form of curve but because it permits the simplest calculations. It is sufficiently accurate for radio frequency calculations.

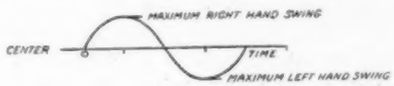


Fig. 1

We are all more or less familiar with Ohms Law relative to the flow of electric energy, this Law is expressed algebraically by the formula:

$$I = \frac{E}{R}$$

The Law is not difficult of comprehension for your common sense will tell you that the volume flow of any medium will depend upon the pressure applied and the opposition to that pressure.

Given any two of factors in the above formula the other one can be found, for instance—

$$E = R\ I \text{ and } R = \frac{E}{I}$$

This Law is also applicable to alternating currents when you take into consideration the effect of electromagnetic induction and electrostatic capacity. In order to show the effect of these two factors their properties will be discussed in detail.

Inductance

It is well known that when a conductor is moved so as to cut across a magnetic field that an electromotive force is generated in the wire, this is equally true when the magnetic field is moved across a stationary conductor. If the circuit is complete a current will flow.

Now when a current flows in a conductor a magnetic field is set up encircling the conductor at right angles. When the wire is wound in the form of a coil these magnetic fields assist one another in establishing a strong magnetic field along the axis of the coil, this principle is much used in telephone work in actuating relays, bell ringers and apparatus of like nature. It is not essential that an electro magnet have an iron core as the electro magnetic field is set up in the air as well as in an iron field but the field in the air is not so strong as in the iron core. The iron core serves to reduce the electro magnetic resistance to the flow of the lines of force. These lines of force are set up around the outside of the coil as well as on the inside but in the opposite direction; the outside field being in the nature of a return magnetic circuit.

Assume that we have a coil of wire in the form of a solenoid and that we connect a battery to the two ends so that a current flows through the coil of wire, a magnetic field is set up and in setting up this magnetic field at right angles to the conductors naturally the lines of force cut across the wires. These lines of force cutting across the wire in the coil generate an e. m. f., causing a current that is superimposed upon that of the battery. It should be understood that it is only when these lines of force are being built up or reduced that this secondary electromotive force is generated. When the current from the battery is in a steady state, likewise the magnetic field, there is no inductance effect.

The polarity of this secondary electromotive force is such that it opposes the battery electromotive force when the magnetic field is increasing and is in the same direction as the battery when the field is decreasing. Thus when a battery is connected to a solenoid coil the current does not jump at once to its maximum value as prescribed by Ohms Law but the counter electromotive generated by the lines of force oppose the flow of current so that it takes an appreciable amount of time for it to reach its full value.

Likewise when the battery is disconnected the e. m. f. due to the contracting magnetic lines of force is in a direction that the current dies down more slowly. You can now readily see that when an alternating current is applied to such a coil that the current change will be opposed the same as though another alternating generator

of the same frequency were cut in series with the line but which is 90 degrees behind the first in phase. The amount of current flowing in the line would depend upon the electromotive force applied to the line and upon the counter electromotive force of this ficticious generator or in the case of the inductance upon counter electromotive force generated by the self inductance of the coil.

The counter electromotive force generated by the coil will depend on two things—first, the inductance of the coil; second, the frequency or rate of change in the applied electromotive force. As the effect of inductance in an alternating electric circuit is to reduce the flow of electric current, it can be expressed in the same units as resistance to direct current.

The value in this case is $2\pi f L$ where $\pi = 3.1416$. This quantity 2π enters because the sine alternating current wave is derived from the circle.

f = frequency of alternating current.

L = inductance expressed in standard units called a Henry.

While this term is expressed as Ohms you can readily see that its effect on the current does not take place at the same time that the regular Ohmic resistance of the line takes place, we therefore designate it by the term Reactance or in this case an Inductive Reactance.

In radio work the frequencies are very high in many cases ranging well above a million cycles per second therefore any inductance that passes an appreciable amount of current is low compared with those usually used in telephone work thus an inductance of .001 Henry, which would present an inductance of 6.28 Ohm at 1,000 cycles, will have a reactance of 62,830 Ohms at 1,000,000 cycles corresponding to a 300 meter wave length.

When we take into consideration the combined effect of both impedance and resistance we have two effects at right angles to each other or, to express it more technically, a 90 degree phase difference.

When we have two forces pulling in different directions the combined effect is greater than either one of them and less than the sum of the two. The direction is also different and somewhere between the two. This is best illustrated by a mechanical example as illustrated by the resolution of forces. Say we have a force of 10 pounds in a horizontal plane and 5 pounds in a vertical plane as shown by Fig. 2.

By completing the parallelogram we find a force of 11.12 pounds at an angle of 26 degrees from the horizontal plane.

In a like manner we can combine reactance and resistance. Assume in the above case that we had 5 Ohms reactance and 10 Ohms resistance the combined action as far as average current flow was concerned would be the

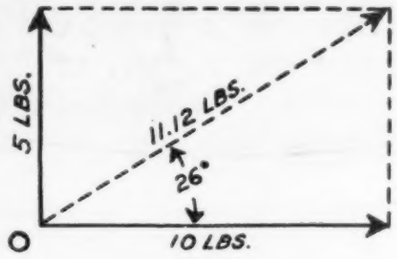


Fig. 2

same as 11.12 Ohms resistance. This combined effect is called impedance. As impedance is made up of both resistance and reactance its value varies with the frequency and can be expressed by the formula.

$$\text{Impedance} = \sqrt{R^2 + (2\pi f L)^2}$$

Using impedance instead of pure resistance R in Ohms Law formula we can make alternating current calculations where inductance and resistance is involved with equal facility as with direct current thus

$$I = \frac{E}{\sqrt{R^2 + (2\pi f L)^2}}$$

Capacity

Two plates separated by air or other insulating medium called a dielectric have the property of storing electric current just as a gas tank stores gas, the amount stored depends upon the pressure applied and the size of the tank. As the electrical pressure is increasing this storing of energy has the effect of accelerating the current flow or is the same as you had a generator in series with the circuit that was 90 degrees ahead in phase with the force applied to the circuit. The effect of the second generator would be to build up the current at an earlier instant of time than would be the case if only the first generator were acting.

There is a reactance effect here also, just as in the inductive circuit, but in this case it is due to a kind of a back pressure caused by the electricity stored in the condenser. This capacitative reactance may be expressed by the formula

$$\frac{I}{2\pi f C}$$

where C = capacity expressed in farads. The other terms being the same as for preceding formulas.

As is well known in telephone work the Farad is a rather large unit for practical work therefore the micro farad, or one-millionth of a farad, is generally used. Even this quantity is rather large where radio frequency currents are involved and a micro microfarad is often used, which is one-millionth of a microfarad.

Inspection of the formula for capacitative reactance will show that the larger the value of the capacity the lower the reactance. For this reason at the high frequencies of radio currents, capacities that would result in negligible reactance at audio frequencies will be of considerable importance.

Thus two parallel wires close together might have as much as 100 micro microfarad capacity to each other and at 1,000 cycles would present a reactance of 1,600,000 Ohms while at 1,000,000 cycles corresponding to a 300 meter wave length the reactance would be 1,600 Ohms and be of considerable importance in some cases.

The effect of capacitative reactance is directly opposite that of inductive reactance therefore where we have capacity and inductance in series the capacitative reactance is subtracted from the inductive reactance, our formula therefore becomes

$$I = \frac{E}{\sqrt{R^2 + \left(2\pi f L - \frac{I}{2\pi f C}\right)^2}}$$

Resonance

This formula shows that where the capacitative reactance equals the inductive reactance one cancels the other and our formula becomes our old friend Ohm's Law. This can take place at only the frequency for any given value of inductance and capacity and where it occurs the condition is called resonance. This principle is much used in tuning radio frequency currents.

A condenser may have large dimensions and a comparatively small capacity thus a wire or number of wires forming a radio aerial is a condenser of which the earth forms the other side. This capacity combined with a inductance can form a resonant circuit which can be made resonant to any desired frequency. Strictly speaking, the aerial also has inductance which must be subtracted from the total required inductance to make the circuit resonant to a predetermined frequency, in order to find the amount of inductance to insert in the circuit.

When alternating current of the proper frequency is applied to such a circuit considerable current may flow through the resonant circuit. This current causes a radiation of waves of the same frequency into space, these waves traveling much the same as waves on the surface of water only instead of traveling on one plane they spread in all directions.

This radiation is inappreciable until the frequency reaches higher values.

LINE AND DESK

REPEATER TUBES HAVE LONG LIFE

Some remarkably long lives have been obtained from telephone repeater tubes where their operation has been carefully supervised. In a talk before a telephone meeting recently, Mr. E. C. Brown, chief testboard man of the Fort Wayne test station of the American Telephone and Telegraph Co. exhibited a tube which had been in service for a total of 28,008 hours on a through line repeater where its filament was lighted continuously. When removed from service to permit the installation of a new type of tube, it met all of the requirements for service for a longer period. Other samples of the same type of tube have been operated in the neighborhood of 24,000 hours at the same station. Mr. Brown pointed out the necessity of careful attention to the operation of the filament at its rated current. In another location, the tube renewals on a single cord circuit repeater where the filament is lighted only when the set is in operation, were greater than for a test station having nine through line repeaters where the tubes are in service continuously. This was found to be due to the fact that the filament current was allowed to run up to 1.4 amperes instead of being kept between 1.2 to 1.3 amperes at which current the filament is supposed to operate.

THE LINE, THE LINEMAN AND THE MINUTE

Once there was a line that was in much trouble. There was a section lineman who was fond of the line, and early one morning he said to it, "I am going to clear your trouble, and I'm going to clear it in a hurry." So the lineman climbed to the top of a pole and said, "I will save a minute and not snap my safety strap."

But soon his foot slipped, and as there was no safety strap around the pole to hold his weight, he fell many feet to the ground and was severely injured. He had saved a minute, but could work no more for many months, months filled with enough working minutes to snap 40,000 safety straps.

The lineman's boss spent the rest of the day of the accident seeing that the lineman was taken to his home, and thereafter called frequently to see him —spending enough working minutes to snap many more safety straps.

The lineman's good wife spent much time taking care of her sick husband. The lineman's doctor and many friends frequently came to see him. Together, the boss, the wife, the doctor and the friends thus spent time which equaled enough minutes to snap 20,000 safety straps.

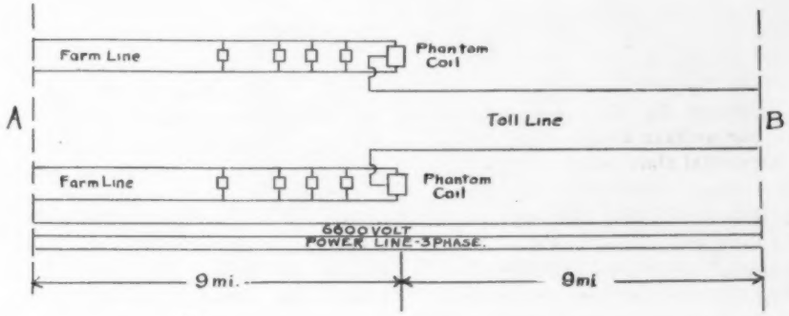
When the lineman was well he returned to work and said, "Ah, I saved a minute, but wasted enough minutes of my own time and of my friends' time to snap all the safety straps in the Bell System several times over."

MORAL: A snap in time saves many an arm or leg.—Long Lines.

A bright inventor has a scheme to eliminate the "not in" trouble of telephoning. When the called party is absent, this device automatically records the message so it can be heard upon his return. The machine to the right contains the machanism which records and transmits the messages

A PHANTOM CIRCUIT PROBLEM

A TELEPHONE ENGINEER subscriber proposed the following problem dealing with phantom circuits: "We have a toll line extending from A to B as shown in the sketch (Fig. 1). For the first nine miles it is a phantom on two

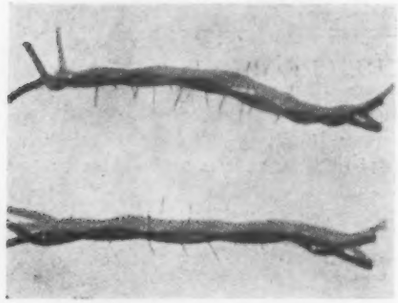


No. 12 BWG farmer lines and extends the remaining nine miles as a physical circuit. Both physical and phantom circuits are transposed. It is paralleled by a 6600 volt transmission line for the entire 18 miles. It is very noisy at all times and yet seems to be balanced as far as a bridge test will show. What suggestion can you make for its improvement?"

Our opinion would be that it could scarcely be called a high grade line under any condition. The noise is undoubtedly due to some unbalanced condition. Even if the resistance of the four wires of the phantom were exactly alike, there might be a capacity unbalance or unbalanced leakage to ground. Another cause of noise might be due to the fact that the transposition scheme does not co-ordinate properly with the transpositions in the power line if the latter line is transposed. Another possible cause of noise is unequal spacing of the telephone transpositions. Careful clearing up of the line and retransposing if necessary might improve conditions somewhat, but the line would always be subject to possible unbalances due to grounds at the lightning arresters at the farm stations, etc. We are inclined to think that the best solution is to string in an additional pair of wires and make the toll line a physical circuit for its entire length. While this would cause some expense, the phantom coils and arresters would be salvaged and should be credited against the expense. In all probability the labor expense of stringing the new wire would not greatly exceed the cost of clearing up the present circuit and a much more reliable circuit would be available.—Staff Contribution.

BUGS WE HAVE SHOT

This section of twisted pair wire was taken from the loop entering a subscriber's house at Columbus, Miss.



The patron was annoyed by sparrows lighting on the wire which passed close to his window, and waking him up in the morning, so he stuck pins through the wires at close intervals. This stopped the sparrows, and also stopped his service.—Southern Telephone News.

Fishing for Trouble

Photo Courtesy N. W. Bell

It sometimes happens that intermittent cases of cable trouble are very difficult to locate. A single pair may go in trouble and be located in a certain span, but when the cable repairman rides out in the cable car the moving of the messenger and the cable will cause the trouble to disappear. Later the trouble recurs and more difficulty is experienced in locating it.

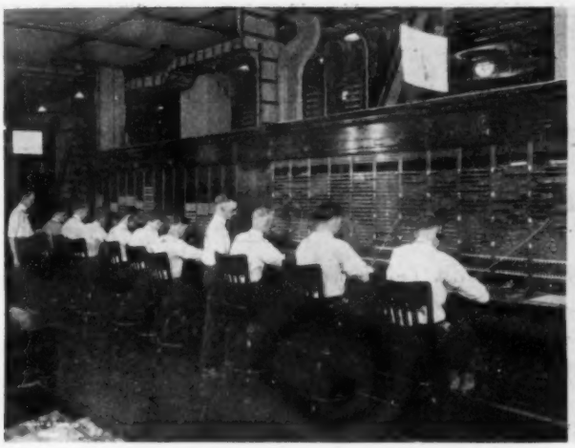
In a recent number of The Northwestern Bell Magazine is a description of an ingenious rod for the location of this kind of trouble without riding the cable. The idea is credited to Carl M. Snyder, a St. Paul cable trouble man. Later H. B. Nelson, cable tester in the Minneapolis District Plant Office, undertook to develop a pole that could be used satisfactorily with one ordinary exploring coil.

The pole that he designed consists of five sections of bamboo which are joined by slip ferrules and fastened by bayonet locks. The top section is provided with a clamp to hold the coil, so fastened in a universal joint that it can be rotated into any position. Connections are made by wires running through the hollow bamboo, terminating at the end of the section in automobile head-light plugs and contact plates. The bottom section contains a jack into which the plug attached to the cord is the head set.

The pole is adjusted by sections and may be used wherever the height of the cable is not more than 24 feet above the ground. It is particularly suited for use on long cable leads running into the country and saves much unnecessary climbing of poles.

Association Requests Changes

At a meeting of the directors of the U. S. Independent Telephone Assn., held in Washington, D. C., May 2, the board voted to present to the Interstate Commerce Commission the opinion that Class B, C and D telephone companies should be relieved from the commission's accounting requirements in all states where a state regulatory body requires accounting and reports from those companies. Also the board urged that the classification of telephone companies by the Interstate Commerce Commission should be changed so that the dividing line between D and C Class companies should be $25,000 annual operating revenues instead of $10,000 operating revenues as at present.



Chicago machine switching—Out trunk-test desk at the right; sender monitor position at the left

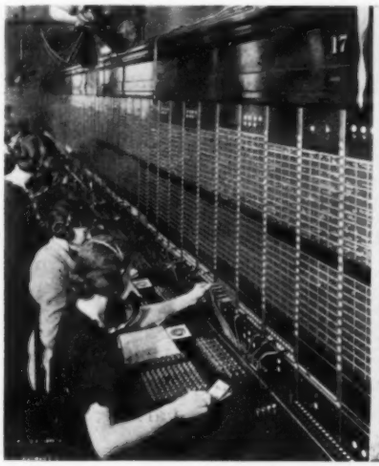
Chicago machine switching—cordless "B" switchboard—central on the left; station on the right

Machine Switching at Chicago

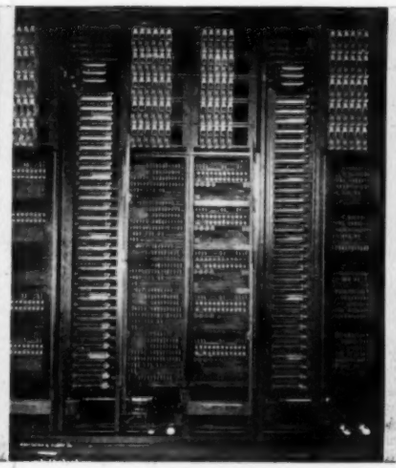
Chicago started "machine switching" telephone service at midnight, Saturday night, June 9. The change affects only subscribers having CENtral numbers, the rest of Chicago's 654,000 telephones being operated, for the time being, as heretofore. Over 15,000 telephones and 550 private branch exchange switchboards were transferred from the CENtral manual office at 69 West Washington Street to the machine switching equipment in the Franklin Building at 311 West Washington Street. At the same time 2,400 trunk lines connecting CENtral with the 75 other offices in the city where transferred.

The machine switching equipment is of the so-called "panel type," manufactured in Chicago by the Western Electric Co. This equipment is the result of 15 years of development work by Bell engineers. This type of equipment already is in successful use in Omaha, Kansas City, Philadelphia, Buffalo, Providence, Seattle and New York City. Another cutover, to be made at Chicago later this year, will be 8,500 STAte telephones and 332 P. B. X. switchboards to the new STAte machine switching unit, which is housed in the Illinois Bell Telephone Building at 311 West Washington Street. Introduction of machine switching telephones will not cause any operators to lose their jobs. It will be a great many years before all the Chicago offices are changed over, and the usual turnover in the operating force will, automatically, take care of any reduction in force. Even with machine switching, operators will always be required to handle special calls, toll calls, information and similar traffic.

A special switchboard is provided where operators complete calls to nearby toll points, such as Oak Park and Evanston, and where subscribers who are unable for any reason to dial numbers for themselves may receive assistance. Calls for not working or disconnected numbers will also be intercepted at this switchboard. The system is protected with so-called "time measure alarms." In event of failure of the apparatus, incomplete dialing or other improper manipulation of the telephone by the subscriber, after a predetermined time interval, alarms are given at suitable locations in the switch-rooms, calling attendants to the assistance of the subscribers in difficulty. This time measure system is uncanny in its accuracy and almost human in its ability to call attention when needed.



Chicago machine switching — semi-mechanical "A" switchboard



Chicago machine switching — sender frame with dust proof door open—each frame carries five senders

Chicago machine switching — final frame,showing "Tea Wagon" test set

OPINIONS AND COMMENTS

VALUE OF SYSTEMATIC INSTRUCTION

The value of a systematic method of instruction of plant men is brought out in a striking manner in the recent paper by Mr. Robert M. Bruce of the Rochester Telephone Corporation before the Upstate Telephone Association of New York. Although the course of instruction has been in operation for less than a year, notable results have been achieved.

Among the worth while things that have been done are the reducing of time of installations because the installer has been taught to clear much of his own trouble, a reduction in repeated trouble of 25% and of total trouble of 15% and a relief from a considerable amount of work on the part of desk men because the outside men could test and clear trouble without calling for repeated tests.

The men were taught the value of material, and naturally became more careful in its use and less wasteful when they appreciated its cost. Relations with the subscribers were improved because the men had been taught the fundamentals of public relations. Other benefits, intangible but none the less valuable were realized as a result of the instruction work.

The Rochester plan, which is designed to operate with as little interruption as possible to the regular duties of the man, seems to be one very well suited to the needs of telephone companies of moderate size and might well serve as a basis from which to work out a plan that could be applied by any company operating from, say, 5,000 stations upward. Telephone men may secure copies by writing to the Association Headquarters at Albany, N. Y.

ASSOCIATIONS AND HEARINGS

The example of the Illinois Telephone Association in appearing at the Depreciation Hearing of the Interstate Commerce Commission is one that might be followed with profit in future matters by other state associations. While the United States Independent Telephone Association has done splendid work in representing the Independent side of the industry and while the Bell system always has been adequately represented, it is our belief, that with proper co-operation the state associations could give excellent assistance to these agencies. We do not presume to say how this matter should be worked out but we are sure that the position of the industry in matters of this kind would be strengthened if the National Association and the Bell system were supported at the hearing by appearance of State Associations as well.

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STANDARDIZATION IN TELEPHONE INDUSTRY

Recently the American Society of Mechanical Engineers sent out a questionnaire to a selected list of its membership and in reply received suggestions of more than one thousand opportunities for the elimination of economic waste through simplification of sizes and varieties of products.

Since the answers were received from professional mechanical engineers, no suggestions of specific application in the telephone industry were made. There can be no doubt that many varieties of equipment and supplies now offered by telephone apparatus and supply manufacturers could be eliminated if a systematic survey were made. Much also could be accomplished in the standardization of sizes of apparatus and parts if a real effort were made.

Much progress has been made in the standardization of traffic methods it is true. In the plant, the Bell system is highly standardized—too much so, say some observers. Outside the Bell system and the few companies that follow Bell practices, there is practically no standardization in plant matters.

A few attempts have been made to standardize materials and performance of equipment but they have not got beyond the limits of a single state or a single company. What is needed is a program that will apply to the entire country and be applicable to all matters not controlled specifically by local conditions. It would seem that this matter is a proper one for consideration by the meeting of executives of the various State Telephone Associations when they next discuss suggestions for the good of the industry.

SOUTHWESTERN BELL DECISION

The decision of the United States Supreme Court in the case of the Southwestern Bell Telephone Company v. Public Service Commission of Missouri, which was announced May 21, 1923, is of very great importance in clearing up several matters which have been subject of much contention in various rate cases.

Probably the most important matter to the industry in general is the clear cut statement that costs of material, labor and supplies, as of the date of the investigation, are necessary before it is possible to ascertain fair rate of return on the property. The opinion says, in part: "An honest and intelligent forecast of probable future values, made upon a view of all relevant circumstances, is essential. If the highly important element of present costs is wholly disregarded, such a forecast becomes impossible. Estimates for tomorrow cannot ignore prices of today."

The Court is here taking cognizance of a fact often overlooked or neglected by advocates of the historical method of determining value, namely: that the rate schedule fixed applies to the future; not to the past. Additions and replacements of plant are being made continually and, under present conditions, at a cost much in excess of costs of earlier years. A rate structure based on historical costs may immediately become inadequate as soon as such additions and replacements are made.

Another point of importance in the decision is that the Supreme Court holds that the Missouri Commission erred in disallowing 55 per cent of the four and one-half per cent payment to the American Telephone and Telegraph Co. The Court takes the view that this is the customary payment paid by the subsidiary companies to the parent company and that, in making the contract, the directors of the Southwestern company had exercised a proper discretion in a matter requiring business judgment. On this matter, the opinion says: "It must never be forgotten that while the state may regulate with a view of enforcing reasonable rates and charges, it is not the owner of the property of public utility companies and is not clothed with the general power of management, incident to ownership."

If this statement in the four and one-half per cent matter is to be taken as general, it may have important applications in other matters that enter into regulation by the states.

SELLING STOCK TO SUBSCRIBERS

In the Annual Report of the Bell system, we are able for the first time to get a picture of the success of the financing operations of the Bell subsidiary companies which offered preferred stock to their subscribers. Four companies made offers of preferred stock, the Southwestern, the Wisconsin, the Chesapeake and Potomac of Baltimore and the New York.

The final result for the four companies was the distribution of 451,656 shares to 151,510 purchasers. The effort was made to place the stock of each company in the territory served by it and a large percentage of the stock was placed by employees.

One noteworthy fact brought out by the sale of this stock was the fact that employees reached individuals who had money to invest and who were not ordinarily reached through banks or investment houses.

The success of the sale of these preferred stock issues which in three out of four cases were oversubscribed, proves that the telephone business can be financed adequately and that the people who are users of the service are willing to put their savings into the business. Any company in need of new capital should take note of that fact.

THE COLLEGE GRADUATE

About the time that this number of *Telephone Engineer* reaches its readers, many thousands of young men and young women will have passed out of college halls with more or less hard earned degrees. They will be going into the world to seek their vocations in business, on the farm and in the home. Eventually, from among their numbers will be found many leaders in various occupations, who will take up the work of the world when the present generation is ready to lay down the burden.

Many of these graduates will find their way into the telephone industry. A thousand or more will find places in the Bell system alone. Others will go to the independently owned companies. Probably a majority of these will be graduates of the technical schools since the telephone has grown to be such a highly technical industry.

For years, the Bell companies have pursued a policy of taking technically trained men from the schools. After a few months of special training in different departments, the new employees are assigned to permanent places in the organization. They are advanced into positions of responsibility as fast as the development of their judgment and knowledge of the business warrants. Scattered widely through the organization as its members are, this group constitutes a reservoir from which a considerable percentage of future executives will be drawn.

In the Independent side of the industry there has been no such policy of selecting and training men who are to become future executives. It is true that a number of companies have taken college graduates, but there are many others who have not done so. In some quarters there may yet be some prejudice against the college man. Even if such prejudice does not exist, many companies have felt that they can not compete with larger companies either in in-

itial salary or in future prospects. Others have felt that they did not care to provide the "breaking in" that a college graduate needs before he becomes a highly productive employee.

We are inclined to think that none of these reasons have much weight. By no means, do all college graduates believe that their best opportunity for the future lies with the large companies. If any reasonable opportunity be offered, a majority of them would prefer to locate near their own homes, or in their own state. This is true, even if starting salaries are smaller. As for future prospects, the smaller company has advantages of its own. It can offer opportunities to become familiar with all sides of the business that a larger company can not give. Furthermore—and this is no small advantage, if properly applied—it can offer direct, partial ownership in the business with which the employee is associated. The "breaking-in" period, which is largely one of becoming familiar with the routine of work, naturally is much shorter with the smaller company where things are done in a more direct fashion.

We have heard much in recent months about the dearth of material from which future managers of Independent plants are to be drawn. The army of young men who pass, annually, from college into industry would seem to be a potential source of such material that warrants development.

A TELEPHONE FABLE

In a certain town, in the old days of telephone competition, there existed two telephone plants, each serving approximately the same number of subscribers.

One was old and decrepit, a veritable junk heap of rusty wire and rotten cross arms. Its switchboard was an 1894 model which did not even have metallic circuit cords and jacks. The telephones included every known make and some that no one knew how or where they were made.

The other was new and shiny. Graceful Idaho cedars lined the Main Street in their tall beauty. The wires were in cables, and all were snug and taut. The switchboard was the creation of one of the best manufacturers and the telephones were the latest style in what was then standard equipment.

The old company had a group of pleasant-voiced operators who did their best to give service over the antiquated switchboard. It had repairmen who worked faithfully to shake out the crosses that blew into the wires and to replace the wires that fell down of their own weight, so that subscribers might not be left out of service. It had installers who got onto the job early to make new installations or moves so that they beat the other fellow to the choice location and got the line working first.

The new company had an operating force that never had heard of the "voice with a smile" and which never violated any speed laws in making quick answering time. Its repairmen had an occasional case of trouble which they took care of whenever they happened to go down into that part of town and its installers didn't worry much if they happened to break loose a large piece of plaster; "It's an old house, anyway."

And so things ran on—until the inevitable happened. There was a consolidation. But this is not part of the story.

The moral of the tale is that neither exchange gave good telephone service. The most energetic and best intentioned people can not give service over a run down plant. The finest plant in the world can not give service if the human beings who operate it are not endowed with the "spirit of service."

Adequate service requires the consolidation of the desire to give the best possible service and the service. Without this consolidation, telephone service of superior quality can never be given.

Proposed Wire Work in Finland in 1923

Helsingfors, Finland.—Improvements to be made during 1923 by the Finnish Telegraph Administration will add greatly to the present telephone connections in northern Finland. An appropriation has been made for the construction of a telephone line between Tornea and Enontekis will be used for the building this year of a copper line from Tornea to Turtola, from which place there runs an iron line to Kobari. From there a copper line will be built to Muonionniska. It is also intended to replace the iron line between Turtola and Kobari with a copper line and to extend the terminus from Muonionniska to Enontekis.

Between Brahestad and Uleaborg there will be erected a new telegraph line and in southern Finland a telegraph line will be built between Viborg and Sordavala. The State has also purchased for a price of 400,000 Finnish marks the telephone lines of Ostra Finlands Telephone A/B. These lines will be taken over on June 1, 1923. They extend from Viborg to the eastern frontier.

Italian Telephone and Telegraph Lines Extended

Florence, Italy.—New poles, nearly all in pairs, have been set up for a distance of 500 kilometers in connection with approving the work of the telephone and telegraph service in Tuscany. This extension has been made in connection with the work of electrification of various railway lines in southern and central Italy. Additional work is under way for the new telephone lines between Florence and Pisa.

Automatic Telephones Proposed for Riga

Riga, Latvia.—A new full automatic telephone exchange to replace the present system in operation in Riga has been proposed by the General Director of the Latvian Post and Telegraph Bureau of the Ministry of Communication. The new project calls for a machine switching telephone exchange capable of caring for 10,000 lines, with a maximum capacity of 20,000 lines. The estimated cost is $600,000.

Chemical Exposition at New York

The Ninth National Exposition of Chemical Industries will be held in the Grand Central Palace, New York, the week of September 17, 1923. Chas. F. Roth is manager.

W. H. Crumb, of Chicago, has been retained by the Nebraska commission to assist its defense of its exchange schedule now being considered by an examiner in the federal court here.

Machine Switching Systems

A Brief Outline of Certain Important Developments in Machine Switching Systems and the Application of These Developments to Providing Telephone Service in Large Metropolitan Areas

By E. B. Craft, L. F. Morehouse and H. P. Charlesworth

Editor's Note.—This article is a portion of a paper on "Machine Switching Telephone Systems for Large Metropolitan Areas" presented at the Midwinter Convention of the American Institute of Electrical Engineers, New York, and published in the Journal of the A. I. E. E.

It is the purpose of this paper to describe this system sufficiently in detail to give a general picture of it, but because of the limitation as to space no attempt will be made to go into the intricacies of circuits and apparatus, which doubtless would be of interest only to the telephone engineering specialists.

Among other requirements, the following must receive special consideration in the design of a machine switching system.

The functions to be performed by the telephone subscriber in getting a connection must be simple and easily understood.

It must work efficiently and with accuracy and speed, and, of course, must be capable of handling the various types of calls that the subscriber wishes to make.

The system must not require modifications in the existing rate structure, otherwise than desirable. If the rate structure calls for message register operation, coin boxes, etc., means must be provided for automatically operating the register and collecting the coins on such calls, and for preventing a charge on calls not answered, calls for free lines, busy lines, etc.

The system should employ, as nearly as practicable, the conventional numbering scheme.

It should work with the existing telephone net work, so that its introduction does not require wholesale number changes and extensive rearrangement or the abandonment of existing switchboards or other plant. Its introduction must, of necessity, be on a gradual basis.

It must be sufficiently flexible in design to care for growth and such changing traffic conditions as occur from time to time.

In large telephone areas, such as the New York Metropolitan area, there is a great variety of calls to be handled and many different classes of service furnished the public, such as message rate, flat rate, official, coin box, nonattended pay station, attended pay station, special services such as information, etc. Not only individual lines but party lines, and private branch exchanges must be cared for, and provision must be made for thousands of toll points, or it may be to some point in a distant city.

Fig. 1—Desk stand equipped with dial

toll messages which must be recorded, supervised and timed.

A call originating in a machine switching office in New York City may have as its destination any one of a great number of points. It may be for another subscriber in the same office or for one in another nearby machine switching or manual office; it may be for one of a large number of suburban

The machine switching system, which is the subject of this paper, meets these requirements. After long-continued laboratory experiments, supplemented by field trials, power-driven apparatus of the panel type has been found to be the most suitable, and is now in successful operation in New York City and in other large cities in the country.

General Plan of Operation

At the expense of some repetition it seems desirable in order to give as clear an understanding as possible as to the operation of the system, to first give a brief outline of how the call is handled and a description of the more important elements of the equipment, before going into a detailed description of the operation of the system.

The subscriber's station is equipped with the usual form of telephone instrument and, in addition, with a calling device known as a "dial," mounted at the base of the desk stand, as shown in Fig. 1. This dial has ten finger holes, bearing letters and figures, as shown in Fig. 2.

In making a call the subscriber will, of course, first refer to the telephone directory. He will find in the directory a listing that is only slightly different from that to which he is accustomed. Typical samples of this new form of telephone listing for New York City are shown in Fig. 7. As will be noted, these conform to the present manual listings, except that the first three let-

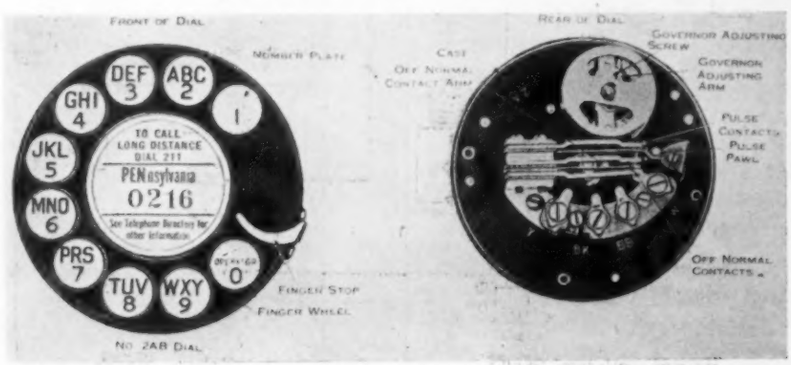

Fig. 2—Subscriber's Dial

ters of the office name are set out prominently. This numbering system will be discussed later in this paper.

Having secured the desired telephone number from the directory, which we will assume is "ACAdemy 1234," the subscriber will first remove his receiver from the hook and will hear the so-called "dial tone," which indicates that

Argent Co, 1400 Bway.....GRE eley 5513
Argentina Brazil & Chile Shipping Co
70 Wall.HAN over 0307
Argentine Genl Consulate, 17 Batry pl..REC tor 6946
Argentine Impt & Expt Corp, Prod Ex...BRO ad 1768
Argentine Mercantile Corp, 42 Bway.....BRO ad 5066
Argentine Naval Commission, 2 W 67..COL mbus 5623
Argentine Quebracho Co, 80 Maiden la....JOH n 1652
Argentine Railway Co, 25 Broad.....BRO ad 1383
Argentine Trading Co, 1164 Bway.....MAD Sq 1871
Argeres Bros, Restrnt, 86 6th av.....SPR ing 5337
Argero A. Grocer, 119 9th av.....CHE lsea 6255
Arghis A, Tobacco, 74 Wall.....HAN over 6311
Argiropie Theodore, Jwlr, 406 8th av..FAR ragut 9772
Argo Packing Corpn, 705 Greenwich...FAR ragut 4505
Argon Dress Co, 24 E 12.....STU yvsnt 2011
Argonaut Supply Corp, 50 Union sq..STU yvsnt 7476
Argonne Steamship Co, 17 Battery pl...REC tor 2493
Argos Ad-Art Co, 1133 Bway.....FAR ragut 5986
Argosy The (A Pub), 280 Bway.....WOR th 8800

Fig. 3—Typical examples of new form of listing telephone numbers

the apparatus is ready to receive the call. He will then insert his finger in the hole over the letter A, rotate the dial until the finger comes in contact with the metal stop shown in the picture, then release the dial, which will automatically return to normal. He will repeat this operation for the letters C and A, and in turn for the four numerals, 1, 2, 3, 4.

This operation of dialing on the part of the subscriber is exactly the same, whether the telephone number he desires is in a manual or a machine switching office. Similarly, the method employed by a subscriber who is connected to a manual office in getting a subscriber connected to a machine switching office, is the same as though the desired subscriber were connected to another manual office.

The progress of a call originating in a machine switching office is briefly as follows:

As will be seen from Fig. 4, the line of the calling subscriber, whom we will assume to be a subscriber in the Academy office, appears in a so-called "line finder" frame. When the subscriber's receiver is removed from the switchhook preparatory to dialing, the line is selected by a "line finder" and connected to an idle "sender" by means of a "sender-selector."

Upon completion of these operations which take but a fraction of a second, the dial tone is sent to the calling subscriber as previously mentioned. When the subscriber dials, electrical impulses on a decimal basis are transmitted to the sender which receives and registers them, translating them in turn to the proper basis for the control of the selectors which are not operated on a decimal basis. The sender automatically causes the particular "district selector" which is permanently associated with the line finder originally used, to select a trunk to the office desired.

Assuming that the call is for a subscriber in the same office, Academy, the trunk chosen will terminate at an "incoming selector" frame and the sender above referred to will cause the call to be routed through the incoming selector to a final selector, and thence to the particular line desired. When the connection is thus completed, audible signals will be sent back to the calling subscriber to indicate that the station is being rung or that the line is busy.

If the call had been for a subscriber in another machine switching office, namely, Pennsylvania, the call would be routed from the district selector to the office desired, either directly or through an "office selector" in case the total number of trunks to all offices is too large to be placed on the district selector multiple. These trunks terminate on incoming selectors at the Pennsylvania office which select the subscriber's line through final selectors, as described above.

If the call is for a subscriber connected to, say, the Worth Office, which is a manual office, the call would be routed from a district selector directly or through an office selector to the "B" board in the Worth Office, where the number desired appears in front of the operator at a "call indicator position" in the form of visible numbers on the keyshelf. The operator is advised of the trunk to which the call is connected by suitable signals, and the call is completed by plugging this trunk into the desired subscriber's line.

Calls originating in a manual office and intended for a machine switching office reach the machine switching office over trunks from the "A" operators in the manual office. At the machine switching end these trunks terminate in incoming selectors, which have access to the final selectors on which the subscriber's lines are located. The selectors are under the control of a special group of senders, and operators are provided with suitable keys for setting up in these senders the number of the desired subscriber. These operators at the machine switching office receive the information as to the desired number from "A" operators in the distant manual office, exactly as is done in the case of manual operation.

The introduction of machine switching equipment does not require radical changes in private branch exchanges. The private branch exchange is provided with dials, and calls to the central office are dialed by the private branch exchange attendant or by the extension user in the same way that the ordinary subscriber dials. No change in the private branch exchange is required for handling incoming calls. An idle trunk in the private exchange group is selected by the mechanism in the machine switching office, in much the same way as an individual subscriber's line is selected.

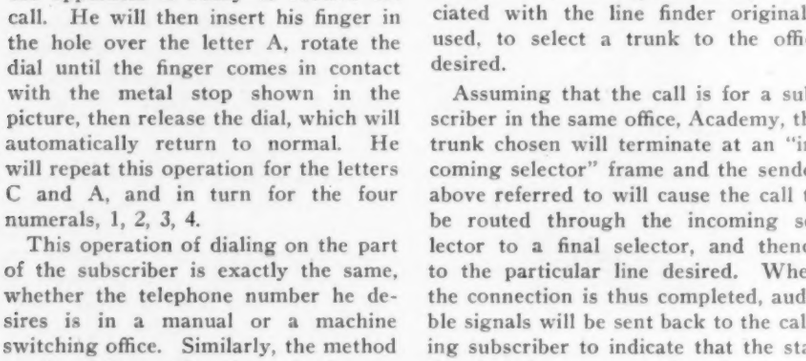

Fig. 4—Diagram showing connections from Machine Switching to Machine Switching, Machine Switching to Manual and Manual to Manual Switching

Numbering System

One of the unique advantages of the plan developed for designating telephone numbers, to which reference has already been made, is that it does not necessitate the abandonment of the existing manual listings. It requires no change except that the first three letters of the office name are set out more prominently. Simple as this change in the form of listing appears, until it was

developed by the Bell System no satisfactory method of designating telephone numbers for machine switching offices in large cities was known.

Many plans had been proposed, to all of which there were serious objections. Some of them required changing the whole system of manual designation, others the use of combinations difficult for the subscriber to use. In small cities a numbering plan employing only digits is sometimes practicable, but in such a large area as we are considering, such a plan would involve seven digits. The subscriber's number would take the form of say 786-3549. Such numbers would be difficult for operators to use and for the subscribers to carry in mind and would require that every subscriber's number in the entire area be changed before the first machine switching office could be cut into service. With the new system, the subscriber's number and office in general remains as before. It is necessary to change only a few conflicting office names in order to make them fit into the system.

Description of the Equipment

A detailed description of each unit employed in this system would be impracticable in this connection, but a brief description of the more important ones will be of interest.

Sender. The use of the sender makes practicable the introduction of machine switching in large metropolitan areas where, of necessity, the service conditions are extremely complex. It is, in effect, the brains of the system, dealing with the subscriber and controlling the selection until the destination is reached, as an operator deals with the subscriber and controls the selection in a manual system. The number dialed conveys the same information to the sender in a machine switching system as the number spoken by the subscriber does to an operator in a manual system.

The sender is an arrangement of relays, sequence switches and selectors, so worked out as to perform the following more important functions:

1. It receives a succession of electrical impulses from the subscriber's dial which are on a decimal basis, stores them and translates them to a non-decimal basis, corresponding to the particular group of lines and trunks that is involved in the path of the call.

2. It controls selecting mechanisms which build up the connection to the called party in such a manner that each mechanism is given the exact time required to perform its functions without any waste of time, independently of the rate received from the dial.

3. It makes the central office designations entirely independent of the arrangement of the trunk groups on the selector frames. This is a very important matter, inasmuch as it allows the selectors to be used to full efficiency. It provides the desired flexibility for growth and permits any desirable rearrangement of the trunks on the selector frames that the telephone company may find desirable at any time.

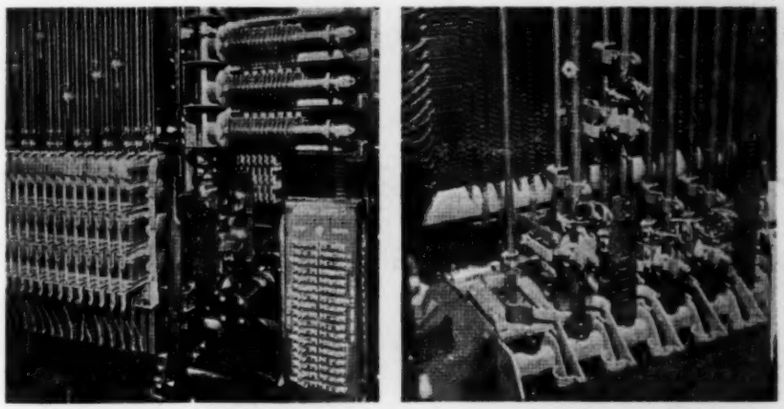

Fig. 5—Views of the Selector

4. The sender is capable of distinguishing the class of office at which the connection terminates. That is, if the call is to terminate at a mechanical office, the sender will arrange to govern the selection accordingly. If the call is to terminate at a manual office, the sender recognizes this and arranges to send out impulses to the call indicator equipment in the manual office.

5. For the completion of certain calls, traffic conditions require the introduction of tandem centers, as discussed later. The sender recognizes calls to be routed via tandem centers and arranges to handle these correctly. The tandem center may be manual or it may be mechanical, and the control must be determined accordingly.

6. Certain senders are arranged to serve lines supplied with coin boxes. These senders are arranged to make a test to determine whether a coin has been deposited and do not allow the connection to be cut through so that conversation can take place until the coin is deposited. If the subscriber does not deposit the coin after a reasonable time has elapsed, the sender connects an operator to the subscriber, and this operator notifies the subscriber of his omission. After the coin has been deposited, the sender allows the called subscriber to be rung and permits the conversation. In case the called subscriber is busy or does not answer, or if the call is to a free line, the sender returns the coin to the calling party. If the called party answers, the sender causes the coin to be collected.

The sender makes a test of the calling line after the subscriber has completed dialing, to insure the deposit of the coin, and recognizes whether a coin has actually been deposited or whether some abnormal condition exists, in which case the call will be routed to an operator who causes an investigation to be made.

7. In large areas, such as the New York Metropolitan area, there are distant points, connection to which requires toll charges. In such cases the subscriber is instructed to dial a special operator who will ascertain his wishes, complete the call, and make the proper charge. Should a subscriber attempt to dial outside of his own local service area, his call will automatically be routed to an operator.

Panel Type Selecting Mechanism.

An important mechanism of a machine switching system is the selector and its associated multiple bank. It is a device by means of which trunks or lines are connected together as required. It performs the same function as the switchboard cord and plug, which in a manual exchange can be plugged by the operator into any one of a number of jacks which are the terminals of trunks or lines.

Fig. 5 shows the mechanical elements of the selectors. The movable member corresponds to the cord and plug of the manual system and the fixed terminals or multiple, to which the movable member can make connection, corresponds to the jacks of the manual system.

Fig 6 shows the fixed terminals or multiple to which the selectors connect. This multiple consists of flat punchings about 3½ feet long and 1 inch wide over all. Each of these strips has lugs on each side with which the selectors can make contact. In this particular panel three hundred of these strips are piled one above the other, separated by insulation, and securely bolted together, forming a panel about 15 inches high. This panel provides a multiple consisting of "tip," "ring" and "sleeve" connection for one hundred lines appearing sixty times; that is, thirty on each side.

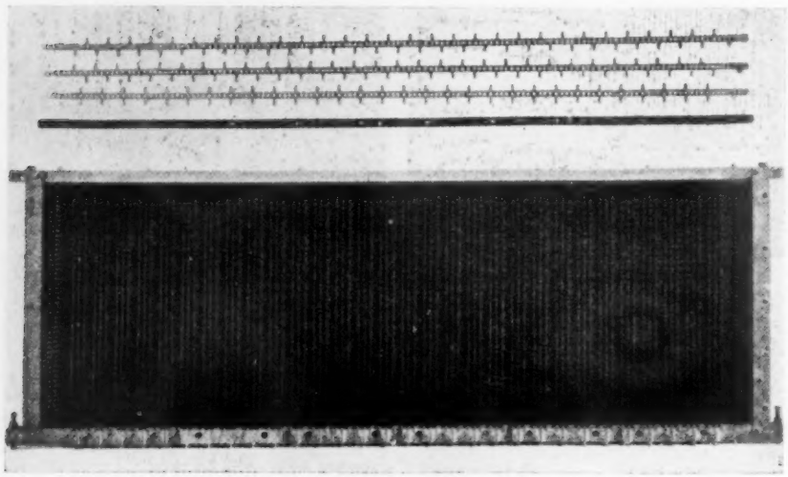

Fig. 6—Selector Multiple Bank

The insulating material consists of special impregnated paper and is of such a nature that, after the panel is assembled and baked, it becomes inert and is not adversely affected by any conditions met with in a central office. It is this panel which has given the name to the system.

The selector (see Figs. 5 and 9) consists of a metal tube supported in bearings allowing vertical motion and carrying five sets of brushes. Each one of the five sets of brushes is arranged to make connections to the tip, ring and sleeve terminals of the panel banks before which it normally stands, and the tip, ring and sleeve contact members of all five of these brushes are multiplied together. They are normally free from contact with the terminals, but any set may be tripped mechanically, so that that set will contact successively over terminals as the selector rises.

A friction clutch is provided at the base of each selector, so arranged that the selector can be raised or lowered by power supplied by a constantly rotating small motor, common to 60 selectors. A magnet is also provided for tripping, by means of a rotating rod, any one of the five sets of brushes into mechanical engagement with the terminals. In choosing a trunk or line, that one of the five sets of brushes which has access to the panel in which the desired trunk or line happens to be, is tripped so that it makes contact with the bank terminals before it. The selector then moves upward, under the proper control, until the tripped brush engages the desired line or trunk. The selector is then held in this position by a pawl associated with the clutch. When the connection is to be taken down, the pawl is withdrawn, and the selector is carried back by means of the power drive controlled by the clutch. When the selector reaches its normal position the tripped brush is reset.

Selectors used for different purposes are arranged to move their brushes upward at different speeds. The speed most commonly employed moves the brushes over the terminals at the rate of 60 trunks per second. At the top of the frame, just above the fifth bank, are located commutators, as shown in Fig 7, one for each selector. The multiple wiring of the brushes on the selector leads to other brushes which move over strips on these commutators, and thereby completes the connection from the movable selector to the rest of the circuit, thus avoiding flexible wire connections with their attendant troubles. This commutator also performs the more important service of controlling the travel of the selector. Brushes moving over conducting segments separated by insulation produce impulses which, when sent back to the sender, indicate to it the exact position of the selecting mechanism.

Sequence Switch. Another device of great importance is the "sequence switch," shown in detail in Fig. 8. It is operated through an electromagnetic clutch from the same motor that drives the selectors.

The sequence switch may be described as a circuit controller or device whose function is to establish in a definite sequence such circuit conditions as are required in the operation of

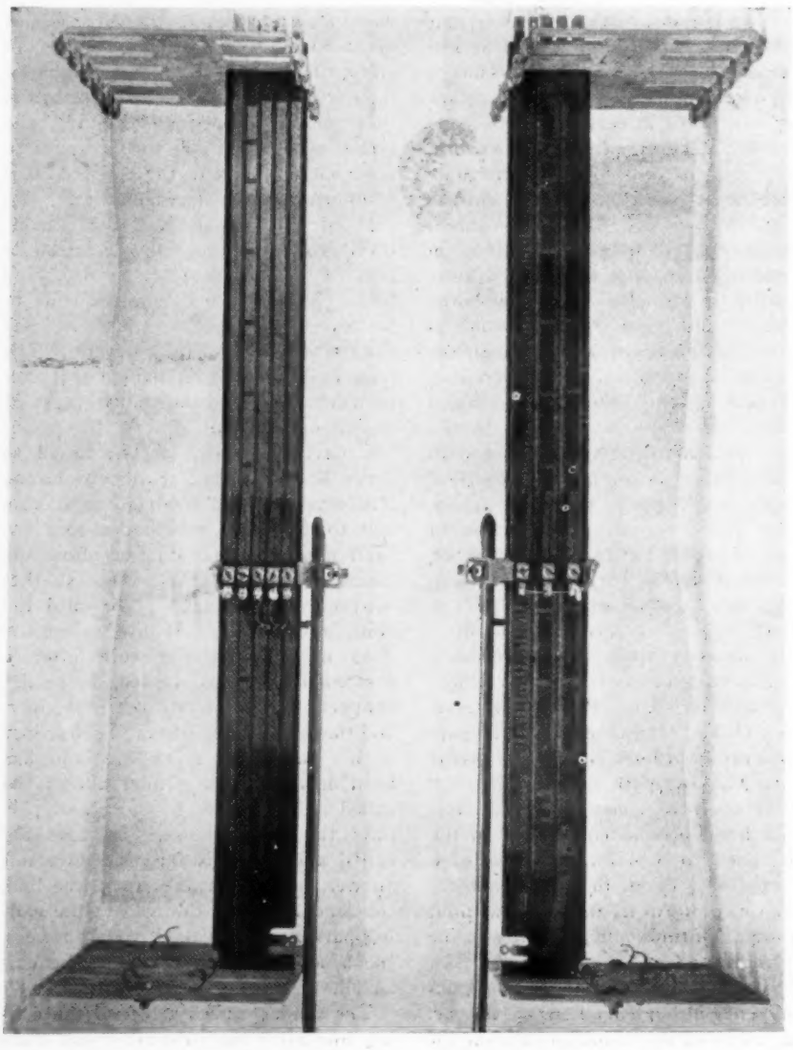

Fig. 7—Commutator for controlling vertical movement of Selecting Mechanism

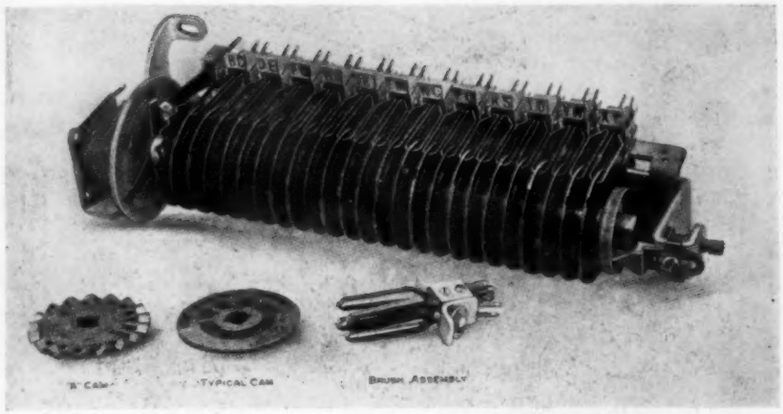

Fig. 8—Sequence Switch Assembly

the system. It is made up of circular disks called cams mounted rigidly on a shaft. The plates of the cams are cut so that brushes come in contact with the plates only when the circuit is to be closed. The sequence switch can be stopped at any one of eighteen different positions as required, by the simple opening of the electromagnetic clutch.

There are many of these sequence switches used in this system, and the arrangement of cutting the cams varies, depending upon the particular circuit combinations which it is desired to establish.

Selector Frames. Fig. 9 shows thirty selectors with all of the associated mechanism mounted upon one side of a frame ready for operation in an exchange. Both sides of the frame are alike. Five panels of 100 lines each are mounted in this frame, one above the other, giving a total capacity of 500 trunks or lines. Thirty selectors, each capable of making connection with any one of the 500 trunks or lines, are placed adjacent to each other on each side of these panels; the entire frame thereby having a capacity of sixty selectors, each of which has access to 500 trunks or lines.

Immediately to the right of the selectors are the sequence switches and, under protective covers, such relays as are used in connection with the selectors upon the frame shown.

Selecting apparatus of this general type, but differing in details of design, is used during the different stages of the call as line finders, district selectors, incoming selectors and final selectors, reference to which has been made before. Fig. 10 shows a section of a machine switching office with some of the typical frames.

The use of apparatus of the substantial construction just described is made possible only through the use of the sender which receives impulses from the subscriber at the rate they are dialed and receives impulses from the selecting mechanism at the rate it is traveling. This obviates the necessity for restrictions in the design of either the dialing circuit or the selecting circuit, such as would be necessary if they were tied together.

Power Supply Arrangements. Since most of the operations normally required in handling a call in a machine switching office are carried out mechanically, it is evident that a considerably larger amount of power is required than with the manual system. Selectors and sequence switches are propelled mechanically by rotating shafts driven continuously by small motors mounted on each frame.

The use of small motors on each frame gives a flexible and reliable source of power, particularly since the motors now being used are of the special "duplex" type developed for the purpose. They consist of two motor elements in one frame, one element being normally driven from the commercial power service and the other being driven by the telephone reserve storage battery to which it is automatically connected by a relay inside the motor when the regular power fails. A power failure, therefore, causes no interruption to the drive. The selectors are arranged so that not more than half in any one group are driven by the same motor which insures continuous service in case of motor failure.

The main power requirement is for direct current at about 24 and 48 volts, which is furnished from motor generator sets (Fig. 11) of special construction to reduce noise, converting the commercial alternating or direct

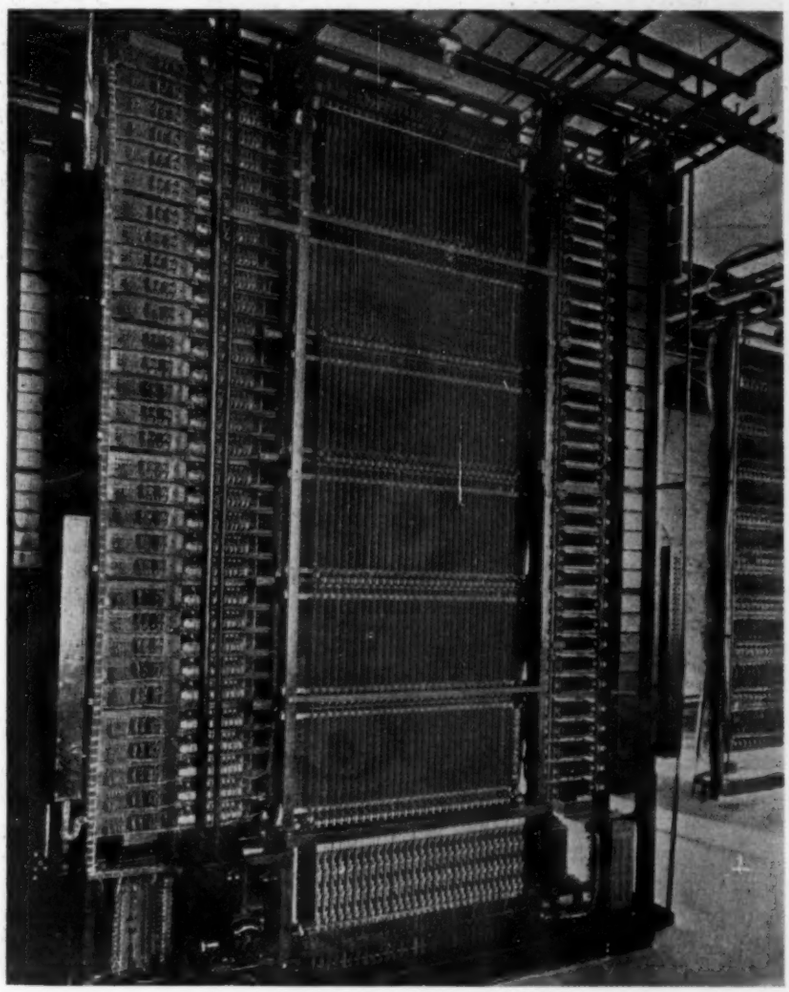

Fig. 9—Selector Frame completely equipped

current into current which is regulated as to voltage and is free from variations which would cause noise in the telephone circuits.

Storage batteries (Fig. 12) floating across the current supply busbars insure regulation. In addition to stabilizing the voltage and reducing noise interference from the machines and between telephone circuits, the batteries perform the important function of keeping the exchange in operation during interruptions to the commercial power service. Small motor generators furnish current for ringing subscribers' bells and drive commutators supplying various tones and signals. Batteries or machines supply current for operating coin boxes, and pulse machines provide impulses for the operation of certain of the machine switching apparatus.

Whenever practicable, two or more commercial power services from independent generating stations are secured, either of which will keep the office supplied. Where independent generating systems are not available a reserve gas engine supply is installed to take the place of the incoming power service, such engine also being equipped for emergency operation on gasoline.

All of the essential power machines and batteries are provided in duplicate and are arranged to come into action automatically wherever this is necessary to insure continuity of service in the event of loss of power or trouble with any of the power equipment. Alarms are provided to detect variations in battery voltage, blowing of fuses, stopping of machines or any failure of service on all power busses which feed energy to the telephone or signaling circuits. The power plant is thus designed to give an uninterrupted energy supply at all times, even when the usual sources of power may have been temporarily discontinued.

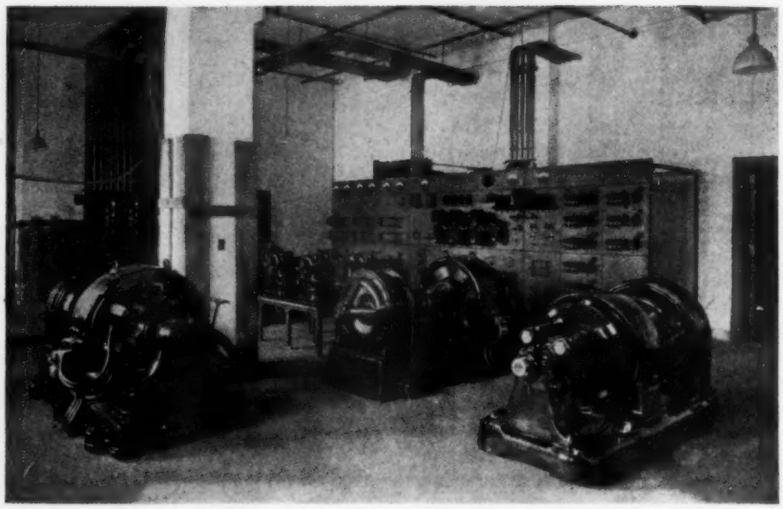

Fig. 11—Power Machine and Control Equipment for two 10,000-line units

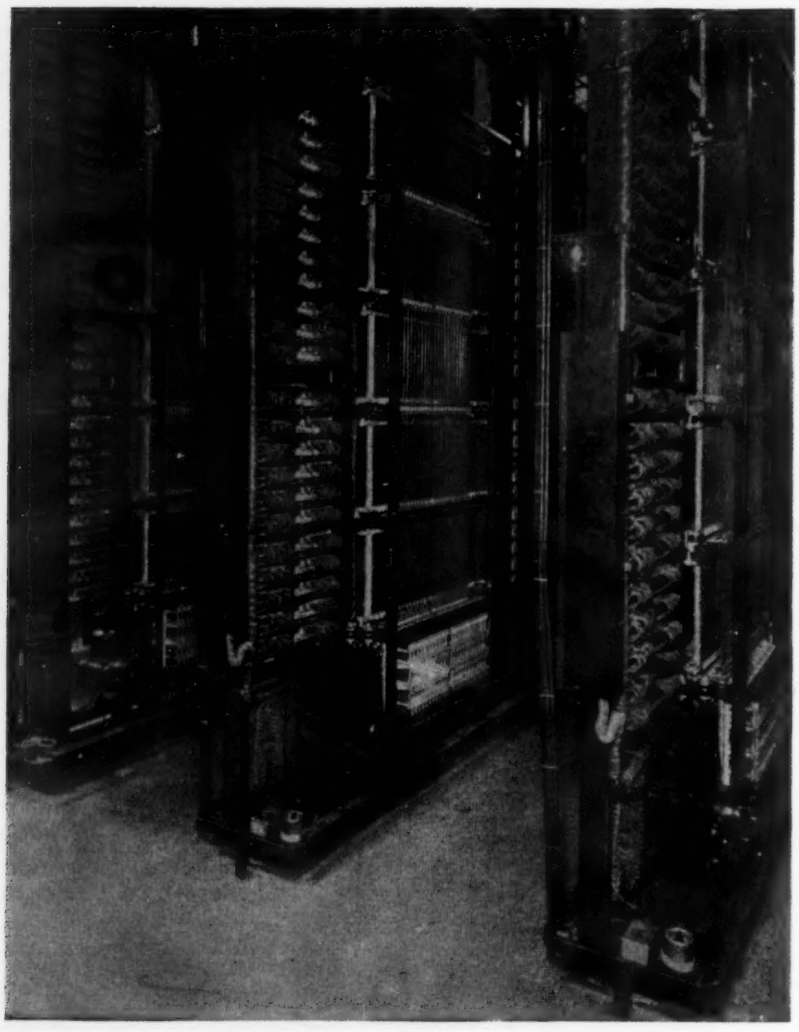

Fig. 10—Group of typical Selector Frames

Australia Plans Big Reformation of State Telephone and Telegraph Systems

Melbourne, Australia.—Under the new Australian Federal Ministry an Advisory Board is to take charge of reforming the activities of the Post-office Department, including the telephone and telegraph services. Approximately $42,750,000 is to be expended. The shortage of telephones in Australia at the present time is estimated at 15,000. According to press reports, applications for new telephone installations are being received at the rate of over 2,500 a month, not more than 1,800 of which can be taken care of by the Department with its present capacity.

Communication Workers Strike in Belgium

Antwerp, Belgium.—On May 12 the Government recalled to the colors all telephone, telegraph, postal and railway employees of the 1915-1922 classes, due to the strike of these employees in the city and province of Antwerp. Any employee not answering the call is liable to court-martial.

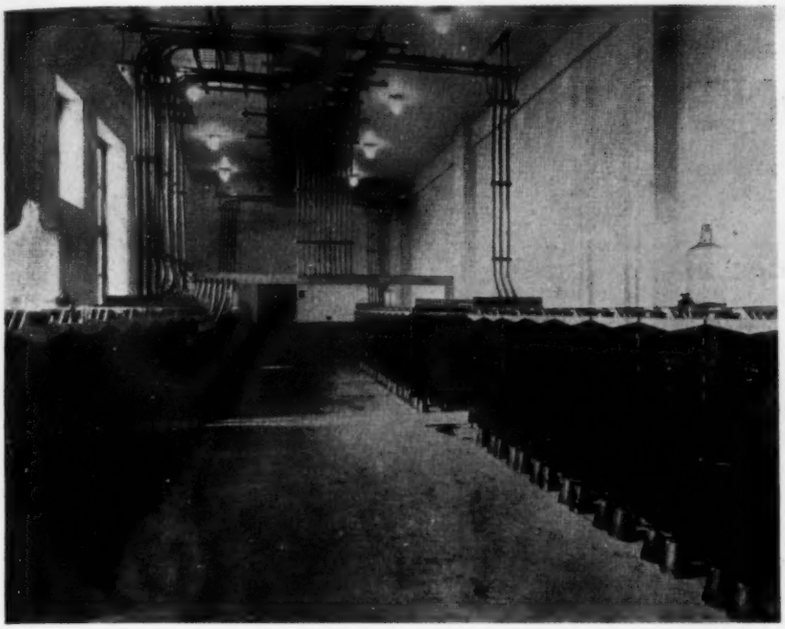

Fig. 12—Battery Room for two 10,000-line units

Leich "Snaps Into It" in Repairing Fire Damage in Ohio

Metamora, O.—A recent fire, which burnt the exchange of the Metamora-Richfield Telephone Co. to the ground, left that company's territory isolated so far as telephone service was concerned. The day following the fire the Leich Electric Co. representative, Campbell, was on the job arranging a temporary board and planning the installation of new central office equipment. An order for a new board with special features was wired to the Leich plant at Genoa, and shipment was made a few days later. In the new switchboard are incorporated features that greatly increase the operating speed of the board and ordinarily are not furnished on a switchboard of 300-line capacity. All line drops are supervised with lamp pilots that remain lighted as long as a drop is down. Cord circuits supervision is obtained by double clear-out signals with pilot lamps and restored by a contact operated by the cam of the listening key. Positive supervision is thus obtained with the fewest possible motions of the operators, and they are allowed to pay very close attention to line calls. Mr. Granger, superintendent of the Metamora Richfield Telephone Co., will be kept busy this season getting the system into shape again, but in the end it will be up to the minute in every respect.

Dinuba, Cal.—The Pacific Telephone & Telegraph Co. is to build five toll lines out of Dinuba and will add two switchboard sections.

Northwest Iowa Holds Operators' School at Le Mars

Le Mars, Iowa.—Under the supervision of Miss Anne Barnes of the engineering extension department of the state college at Ames, a successful operators' school was held here. The Plymouth County Telephone Co. was hosts to the event. Papers read included: An address on the qualifications necessary for operators by Miss Agnes McGrath, chief operator of the New State Telephone Co. of Sioux City; "Industrial Iowa," by R. H. Holbrook of Ames; a classified calls dialogue by Miss Marie Ryan, Catherine Wellendorf, Audrey Sedgwick, Helen Callfas and Mabel LaTurno; "Public Relations, Company Standpoint, Subscribers' Standpoint" by Sidney Lent, manager of Northwest Bell Telephone Co., Sioux City. "How Correct Ticket Details Aid the Commercial Department," F. L. Schuyler, district traffic chief, Northwest Bell Telephone Co., Storm Lake. "Value of System and Co-operation," Miss Helen Richardson, student instructor, N. W. Bell Telephone Co., Sioux City. "Relation of the Operator to the Public," Miss Marie Ryan, Le Mars. "Classification of Rates," Miss Anna Amundson, Sioux City.

Five Hundred Essays Submitted in United Telephone Contest

Abilene, Kan.—"What the Telephone Means to Our Community" as a prize essay subject proposed by the Bureau of Public Relations of the United Telephone Co. drew 500 essays from high school students in the United territory. The first prize was $20. Best paper in each school won a $5 prize.

Defends Commission Regulation of Telephones

Athens, O.—In an address before the Athens Chamber of Commerce, G. C. Maxwell, attorney of Columbus, Ohio, and former secretary of the public utilities commission of Ohio defended the commission form of regulation of public utilities. A portion of Mr. Maxwell's remarks dealt with the telephone industry and they are quoted as follows:

Telephone service does not involve the delivery of a commodity to a consumer, such as gas, electricity, water, or steam for heating. The function of telephone service is to transmit the human voice, human intelligence, if you please, between not only persons within the corporate limits of a municipality but between those residing in adjacent and distant communities. For the good of all concerned this service may not be arbitrarily confined to municipal boundary lines, nor is it proper that in any way communication between residents of various communities be interfered with or made more difficult or inconvenient. Our larger cities are great metropolitan areas comprising many separate municipal corporations. It has been the policy of telephone companies and commissions in the fixing of telephone rates and providing for efficient service, to give consideration to the needs of the metropolitan area as a whole, rather than to make restrictions based on arbitrary municipal boundary lines. Let us suppose that the city of Cleveland should fix telephone rates within its boundaries and that Lakewood should do likewise. Without a commission, who would fix the rate for the man living in Cleveland who desires to talk to his neighbor across the street in Lakewood? The same situation would obtain if the county were the unit of regulation. It can readily be seen that only through a state body can there also be regulation of long distance and rural rates and service.

Suspect Radio "Joker" in Franchise Application

Sterling, Ill.—Local council claims that in the Illinois Bell's request for a franchise giving that company the privilege to supply inhabitants with a public means of communication by telephone "or other electrical devices" there, is an attempt to control the future development of radio for commercial use.

Harrisburg, Ill.—W. L. Ford has become a stockholder in, and secretary-treasurer of, the Harrisburg Independent Telephone Co. He plans considerable extension of the company's facilities.

TELEPHONE BOOKS

A Select List of the Best Books at Present Available on This Subject:

AMERICAN TELEPHONE PRACTICE. By Kempster B. Miller. Fourth edition, 904 pages, 6½x10, 643 illustrations. Price, $5.00

AUTOMATIC TELEPHONY. By Arthur Bessey Smith and William Lee Campbell. 430 pages, 6x9, 315 diagrams and illustrations. Price, $5.00.

HAWKINS' PRACTICAL LIBRARY OF ELECTRICITY. Ten volumes, of which volumes 7 and 8 are especially valuable to telephone men. Price, $1.00 per volume when entire set is ordered, or $1.50 each for separate volumes.

MODERN AMERICAN TELEPHONY IN ALL ITS BRANCHES. By Arthur Bessey Smith. New Edition, new title and new price to be announced soon.

PUBLIC UTILITY RATES. By Harry Barker; 387 pages. Price, $4.00.

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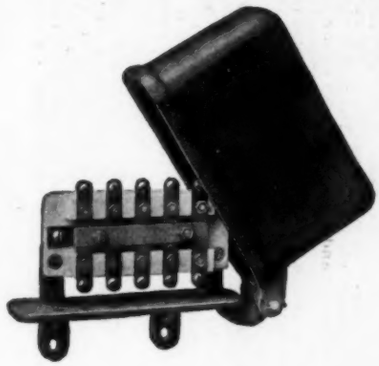

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MATTHEWS RE-ORGANIZED

St. Louis Organization Now Is W. N. Matthews Corporation—Same Owners

St. Louis, Mo.—W. N. Matthews Corp. has taken over the business of W. N. Matthews and Bro., Inc., W. N. Matthews remains as president. Claude L. Matthews is secretary-treasurer and C. C. Fredericks is vice president and general manager. James R. Kearney, will be manager of sales, for the Electrical Division and Louis P. Murray, Manager of Sales, for mechanical painting division.

W. N. Matthews & Bro., Inc., was established in 1899 by W. N. Matthews who prior to that time was in the electrical supply jobbing business and was one of the organizers of the Electrical Supply Jobbers' Association.

Claude L. Matthews became the junior partner in 1901 after spending a year and half in the employ of Packard Electric Co. of Warren, O., where he obtained his first job after leaving the engineering school at Princeton University. James R. Kearney, joined the organization in 1905 as salesman after resigning his position of Superintendent of Construction of the Topeka Edison Co.

Sales organizations are maintained in the principal cities of the United States. The Matthews line of electrical equipment, anchors and other line equipment is well known throughout the telephone industry. The mechanical painting division was inaugurated three years ago by Matthews to place on the market some equipment that has proved itself in many practical tests to which Matthews and others had subjected it. The sales of the equipment rapidly extended, and now include many installations for painting interiors and exteriors of buildings, poles, bridges, transformers and a big and diversified line of mechanical products.

Washington Convention; Blaine, June 22-23

Blaine, Wash.—The annual convention of the Washington Independent Telephone Assn., will be held here June 22 and 23, according to the announcement of Secretary W. M. Anderson of Wenatchee.

Bell Telephone Income

The Bell Telephone Co. of Pennsylvania for the three months ended March 31, 1923, reports gross earnings of $10,080,289 and net earnings of $2,110,213. The total income was $2,644,315, of which $1,587,466 was net. The company for the quarter showed a surplus of $387,466.

Northeastern Indiana Features

Fort Wayne, Ind.—The Home Telephone and Telegraph Co. was host to the annual meeting of the Northeastern Indiana Telephone Assn., held here May 22. President Barnhart of the state association, who spoke, stressed the importance of first class toll service. Other addresses were made on "Some Telephone Problems," by R. V. Achatz; Carl Wilde, director of service, Public Service Commission of Indiana; "Telephone Repeaters," by S. J. Ewald, district plant superintendent, American Telephone & Telegraph Co.; F. V. Newman, general manager, Laporte Telephone Co.; "The Operators' Part in Public Relations," by F. F. Davis, division traffic superintendent, Indiana Bell Telephone Co.; "Employes' Relations," by R. M. Loomis, division traffic superintendent, Indiana Bell Telephone Co., and on "Loyalty," by E. L. Gaines, traffic superintendent, Home Telephone & Telegraph Co.

The officers were re-elected, leaving the official roster as follows: P. J. Maloney, Columbia City, president; C. L. Knipple, Huntington, vice-president, and Martin Umbach, Home Telephone & Telegraph Co., secretary-treasurer.

The Keystone Telephone Co., Philadelphia, Pa., had, in March, the largest gross earnings in its history.

ALTERNATING CURRENTS (EE-5-60)

SELF-INDUCTION

PARALLEL CONDUCTORS. Every current carrying conductor possesses the property of inductance to some degree regardless of whether it is wound up into the form of a coil or is stretched out in the form of a straight conductor. Every current carrying conductor is surrounded by a magnetic field which is proportional to the current in amperes, and this field in turn induces superimposed electrical currents in the conductor whenever the current varies in magnitude. With alternating current circuits, in which the value of the current changes periodically, the effects of the "induced" or superimposed currents is very marked since each current fluctuation results in a counter-electromotive force which opposes the original current.

When a constant voltage is impressed upon an inductive circuit, the current does not attain its full value instantly as it is first opposed by the induced counter-electromotive force due to the rapid change taking place in the value of the surrounding magnetic field. The induced current gradually grows less until the impressed current attains its full value, a period of time which is theoretically infinite. The rate of change of flux is a maximum at the first instant of application and grows less as the impressed current increases, and in infinite time the rate of flux change becomes zero. As we cannot deal with infinite time in practical work, it is usual to determine the time taken for the impressed current to attain 63.2 percent of its full value. This period is called the TIME CONSTANT.

As before explained, the unit of self-induction is the henry or a sub-division of this unit called the millihenry which is 1/1000 of a henry. These units vary in different circuits depending upon the cross-section of the conductor, the size of the conductor, the shape and size of the circuit, the magnetic permeability of the conductor and that of the surrounding medium, upon the specific resistance of the conductor, and also upon the frequency of the current when the skin effect is relatively large. The current is of course of primary importance.

The coefficient of self-induction (unit) is defined as being the ratio of the number of magnetic lines of induction produced by a current flowing in a circuit, divided by the current in the circuit. With a finite cross-sectional area of conductor, the exact definition of the coefficient of self-induction is the ratio of twice the energy of the magnetic field produced by the current flow to the square of the current. The instanteous E. M. F. induced in a circuit by any change in the current flow is given by:

$e = \frac{d}{dt}(L_i)$ under all conditions, or:

$e = -L\frac{di}{dt}$ in circuits containing no iron or where L is constant.

Knowing the inductance in henrys and the ohmic resistance, we have:

$$\text{Time constant in seconds} = \frac{\text{henrys}}{\text{ohms resistance}},$$ or if the applied volts and final amperes of flow are known, we have for a constant applied voltage:

$$\text{Time constant in seconds} = \frac{\text{henrys} \times \text{final amperes}}{\text{applied volts}}$$

If the impressed E. M. F. is alternating instead of constant, and if it varies according to the sine law, the effective value of the induced counter E. M. F. is $E = 6.283fLI$, where f = cycle per sec., I = effective value of current, and L = coefficient of self-induction. The induced E. M. F. lags 90° behind the current.

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John B. Rathbun
Author of the famous Telephone Tables

ALTERNATING CURRENTS (EE-6-60)

CAPACITANCE

CAPACITY OF PARALLEL WIRES. When there is a difference of potential established between two or more conductors in a circuit, then these conductors act like the plates of a condenser with the intervening air or insulation taking the place of the dielectric. This results in a static charge on the conductors. With an alternating current in the circuit, the "capacity E. M. F." leads the current by 90° and the E. M. F. required to oppose or overcome the capacity E. M. F. lags 90° behind the current. The current required to discharge the condenser capacity of the conductors is called the "charging current."

With two conductors, as with a single phase circuit, the static charges on each of the conductors are equal and opposite. The capacity of the conductors when acting as the plates of a condenser depends upon the size and shape of the conductors, upon the nature of the dielectric or insulating medium separating them, and upon their separation distance and their distance from other conductors.

The dielectric effect is very marked, and the relative effect of the dielectric or insulating medium is expressed numerically by the "specific inductive capacity," the capacity of air being taken at unity or 1.000. Such materials as mica and glass may have specific inductive capacities as high as 8.00 or 9.00. In telephone wires run in the open, the dielectric is air and the capacity is relatively low, but in cables where the wires are covered with insulation the capacity between truly parallel conductors may be very high owing both to the nature of the insulation and the short distance between the conductors.

With two conductors, the ratio of the charge (q) on one of them to the difference of potential (e) between them is called the capacity (C) of the condenser. This is shown by the equation:

$$C = e/q.$$

With (q) in coulombs, and (e) in volts, the unit of capacity is the FARAD. This is so large a unit that the one-millionth part of the farad or the MICROFARAD is used in practice as the unit of capacity.

With alternating currents, employing a sine form wave, the effective value of the E. M. F. (E) of the condenser for a given charge is expressed by:

$$E = \frac{10^6}{6.283fC}$$

The right hand portion of the equation is the CAPACITY REACTANCE or the CAPACITANCE of the circuit. The reciprocal of this quantity is the CAPACITY SUSCEPTANCE, that is, the quantity used in calculating the capacity of long lines or transmission circuits. The capacity susceptance is:

$$\frac{6.283fC}{10^6}$$

The charging current required for charging and discharging a condenser or line containing capacitance by an A. C. current of sine wave form, is given by the equation:

$$\text{XX Ic} = 6.283fCE \times 10^{-6}$$

DISTRIBUTED CAPACITY. On long lines the capacity effect is distributed over the entire length of the conductors, or in effect, it is similar to placing a single small condenser at each point in the circuit, the total being equal to the sum of this small condensers connected in parallel. This effect is totally unlike that produced by concentrating a single large condenser of the given capacity at one point in the circuit and the exact effect involves the use of hyperbolic functions. For practical purposes it is customary to approximate the distributed capacity by considering a condenser of half the capacity connected across the line at either end. Dividing the capacity into three equal parts and placing the equivalent condensers at the ends and center is closer.

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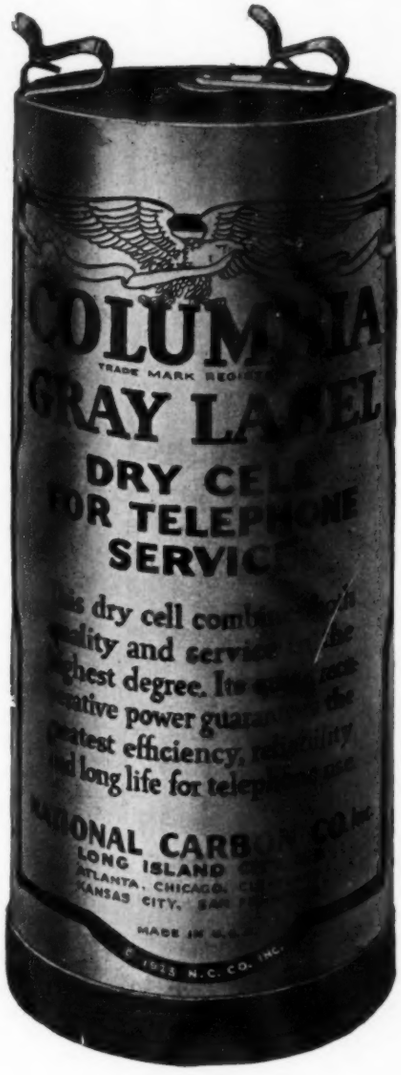

Telephone men demand a smart response from their batteries when asked for—but no fidgets when told to keep still. The corrosive sulks between visits—that's what consumes the energy of most batteries. Columbia Gray Label Batteries work to perfection, then they save their power by resting contentedly while there's nothing to do; thus they cost less per month of service. Fahnestock Spring Clip Binding Posts at no extra charge.

NATIONAL CARBON COMPANY, INC.
Long Island City, N. Y.

Atlanta Chicago Cleveland
Kansas City San Francisco

Columbia Gray Label Batteries now have a jacket of the new design shown here

Columbia Telephone Batteries

"less cost per month of service"

ALTERNATING CURRENTS (EE-5-61)

SELF-INDUCTION

PARALLEL CONDUCTORS. In long lines or transmission systems where the conductors are extended in practically straight lines and are relatively spaced by considerable distances in regard to the diameter of the conductors, we have a different inductive relation than that with wire wound in coils or helixes. Again, the cross-sectional form of the conductor in the line conductors has a greater influence on the induction. The question of phase also enters into the problem and the relative arrangement and spacing of the wires in a polyphase system.

The self-induction of a stranded wire (cable) is slightly less than that of a solid wire of the same cross-sectional area, and slightly greater than that of a solid wire of the same diameter. The exact self-inductive value of a stranded conductor is a complicated calculation which involves the size and number of the individual strands of wire in the cable. However, the difference between the induction of stranded cables and solid wire may be neglected in practical work where great precision is unnecessary.

SINGLE PHASE (TWO WIRES). The simplest system is the single phase alternating current circuit consisting of two wires. In the following equations, the wires are assumed of the usual solid cross-sectional form of either magnetic or non-magnetic material. For ease in calculation, the formulae are based on gauge number diameters, that is, the diameters are given in terms of the Brown and Sharpe gauge instead of in inches. The wires are assumed as running parallel, both sides of the circuit being at finite distance.

Let D = distance or spacing between the two wires in inches.
r = radius of round wire in inches (radius of cross-section).
n = gauge number of wire in B. & S. gauge.
l = length of line (length of one wire) in 1,000 feet.
L = self-induction of 1,000 feet of wire in millihenrys.
f = frequency of A.C. current in cycles per second.
X = inductive reactance of 1,000 feet of wire in ohms. This is the total opposition offered by the counter-electromotive force, but does not include the ohmic resistance.

The total inductive reactness (X) of 1,000 feet of wire, regardless of conductor arrangement is expressed by:

$$X = 6.283fl \times 10^{-3} \text{ in ohms}$$

For the two wires, the self induction is expressed by 2lL, and the total inductive reactance of both parallel wires becomes 2lX. This of course, is twice the reactance (X) of the single 1,000 feet wire.

For non-magnetic wires, such as copper or aluminum, we have the induction of 1,000 feet of wire in millihenrys:

$$L = 0.01524 + 0.141\log_{10}\left(\frac{D}{r}\right) = 0.00705n + A$$

$$\text{where } A = 0.141\log_{10} D + 0.1258$$

For magnetic or iron wire, we have a somewhat different equation which involves the magnetic permeability (or magnetic conductivity) of the iron or other magnetic material. The permeability (u) varies with the grade of the iron and also varies irregularly with the current. The following is only an approximation since the permeability is assumed constant over the entire area of cross section, but for practical purposes the formula is practically accurate enough for ordinary work.

$$L = 0.01524u + 0.141\log_{10}\left(\frac{D}{r}\right)$$

For ordinary telegraphic or telephonic iron wire, u = 150, hence

$$L = 2.286 + 0.141\log_{10}\left(\frac{D}{r}\right)$$

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ALTERNATING CURRENTS (EE-5-62)

SELF-INDUCTION

VALUES OF CONSTANT "A". The constant re-calculation of the awkward expression $A = 0.14\log_{10} + 0.1258$ is a tedious undertaking, hence values for this constant have been tabulated below for the ordinary distances used in spacing wires (D). Any intermediate value of (D) falling between the tabulated values can be easily interpolated by averaging with fair accuracy.

VALUES OF CONSTANT "A"

(D)	(A)	(D)	(A)
⅜"	0.0662	12"	.2768
½"	.0837	18"	.3015
¾"	.1083	24"	.3190
1"	.1258	36"	.3436
2"	.1679	48"	.3611
3"	.1925	60"	.3747
6"	.2347	72"	.3857

VALUES OF "N" FOR LARGE CABLES. The value of (n) in the foregoing equations includes wire sizes up to and including No. 9 in the Brown and Sharpe gauge system. For sizes larger than this, and for the "circular mil" sizes of cables, the following tabulated figures should be used. It should be particularly noted that the values of (n) are negative.

VALUES OF "n" FOR LARGE WIRES AND CABLES

Size	(n)		
No. 00	-1.000	450,000 C.M.	-6.295
No. 000	-2.000	500,000 C.M.	-6.752
No. 0000	-3.000	600,000 C.M.	-7.544
250,000 C.M.	-3.743	700,000 C.M.	-8.212
300,000 C.M.	-4.535	800,000 C.M.	-8.792
350,000 C.M.	-5.203	900,000 C.M.	-9.302
400,000 C.M.	-5.783	1,000,000 C.M.	-9.760

THREE PHASE ARRANGEMENT. In the three wire, three phase circuit, the three parallel wires are spaced in the form of an equilateral triangle, the spacing distance (D) being measured from center to center of wire parallel to the sides of the imaginary triangle. The total self induction per phase, a phase being the circuit formed by any two wires, is expressed by

$$\sqrt{31L}$$

The total inductive reactance per phase

$$\sqrt{31X}$$

The value of (X) is determined as under single phase circuits.

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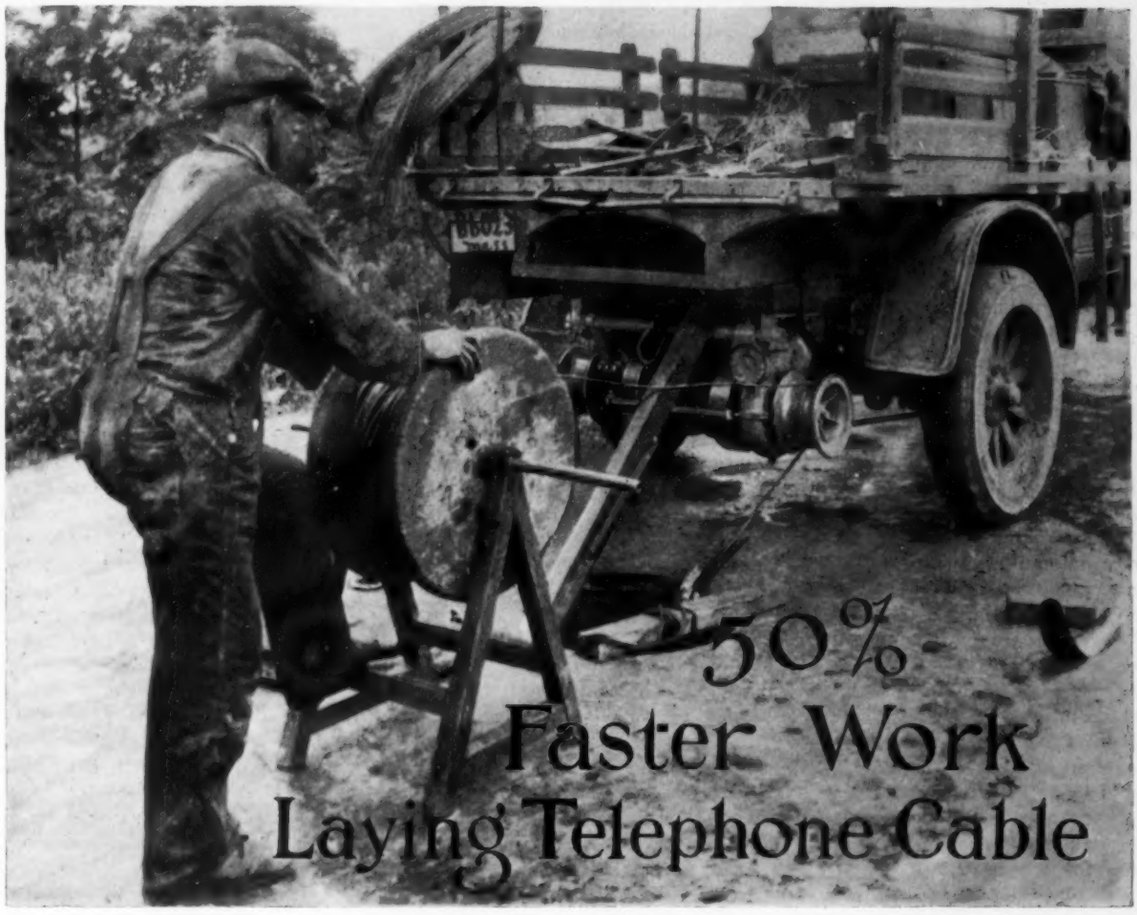
UNDERSLUNG WINCH



Fifty percent faster work laying underground cable than by any other method. The pulling cables are carried on spools, and handled on the winch niggerheads. This allows several pulling cables to be placed in other ducts while one pulling operation is taking place. No time lost—the winch drops one and picks up another. The rope pull and speed are constant, and the operator can tell instantly by the "feel" if any obstruction is met in the duct. This lessens the possibility of pulling away the hitch on the cable casing, or damaging the cable.

The Mead-Morrison Underslung Winch is equally efficient at aerial cable-hauling, loading reels and handling poles.

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Valuation in Rate Making

Chapter XV—A Boost for the Reproduction Cost Theory

By Charles W. McKay, Associate Editor*

On May 21, 1923, the Supreme Court of the United States handed down an opinion which is so important that we, who are interested in the subject of valuation for rate making, can well afford to interrupt our consideration of Collateral Costs (the subject of the last article) to review this decision. In the majority opinion the court said:

"It is impossible to ascertain what will amount to a fair return upon properties devoted to public service, without giving consideration to cost of labor, supplies, etc., at the time the investigation is made.

"An honest and intelligent forecast of probable future values made upon a view of all the relevant circumstances, is essential. **If the highly important element of present costs is wholly disregarded, such a forecast becomes impossible. Estimates for tomorrow cannot ignore prices of today."**

The majority opinion, from which the foregoing excerpt is quoted, was written by Mr. Justice McReynolds, in the case of The State of Missouri **ex rel.** Southwestern Bell Telephone Co., plaintiff in error, vs. Public Service Commission of Missouri and John A. Kurtz, Edwin J. Bean, Hugh McIndoe et al., etc., in error to the Supreme Court of the State of Missouri.

Pause for a moment and consider what this one excerpt from the court's opinion may mean. **During the past few years many public service commissions have entirely ignored reproduction costs in determining the value of public utility properties for rate making purposes.** These commissions have contended that "investment," as reflected through the medium of book records of original cost, should constitute the only element of value to be considered in connection with telephone (and other utility) rate cases. There is a fundamental weakness in this contention. In the history of many telephone companies. it has been proven, repeatedly, that unavoidable errors have crept into methods of cost keeping. In other words, items which should have been charged to the capital accounts were charged to the operating, or expense, accounts. Again, it frequently happens that records of original cost are lost or destroyed by fire. It so happened that the writer read of a case, only a day or so ago, where all of a utility company's records were destroyed by fire, some years ago, and at that time the company—guided by such data as it then had in its possession—placed an arbitrary valuation of some $12,000,000 upon the property. Subsequent plant construction amounted to nearly $13,000,000, so that the total value of the property was estimated (on an original cost basis) at $25,000,000. The very fact that a more or less arbitrary original cost estimate of $12,000,000 had been placed upon the books—immediately after the fire—was a source of serious embarrassment to the company in connection with this recent rate case. Undoubtedly, the $12,000,000 estimate of original cost was conservative, but in view of the fact that the company was obliged to submit an original cost statement of all property values, this $12,000,000 figure was naturally open to attack by opposing counsel.

And so it is in nearly all so-called "original-cost" valuations. A part of the data is found to be missing and it becomes necessary to make estimates. Such estimates are always open to question, for in the last analysis we have a "hodge-podge" of original cost figures and, what are in reality, **reproduction cost estimates,** as of a certain date. Hence, the purpose of the original cost valuation is defeated.

Again, if we are to base our estimate of property worth upon original costs (incurred sometime ago, during the period of low prices) and pay operating costs upon the basis of material and labor prices prevalent today, it is quite obvious that an element most unfair to owners of public utility stock, will be introduced. In this connection, we must remember that many of the stockholders of the public utility companies of today are relatively small investors—many of them subscribers to public utility service.

Undoubtedly, the majority opinion of the Supreme Court of the United States, above referred to, will have a very real effect upon the future actions of the various state regulatory bodies. The opinion is most interesting to the writer—as it probably will be to the readers of TELEPHONE ENGINEER who have followed this series—in view of the fact that all of our discussion of unit costs has been predicated upon the reproduction cost theory. As will be remembered, in nearly every instance we have assumed a five-year-average analysis period in building up the unit costs. While preparing this series, the writer was well aware that many public service commissions were inclined to ignore the reproduction cost theory but, nevertheless, he felt this theory to be so important that it has been used as a foundation for the entire series of articles. In this connection and in fairness to the state regulatory bodies, it may be said that many of our best public utility commissions now are giving, and always have given, due consideration to the importance of reproduction cost as "one element to be considered" in determining the fair value of telephone property for rate making.

In connection with the Supreme Court decision in the Southwestern Bell Telephone Co. case, it is interesting to note that a dissenting opinion was filed jointly by Mr. Justice Brandeis and Mr. Justice Holmes. The writer has not had an opportunity to review this dissenting opinion in detail, but judging from the excerpts from the opinion which have come to his attention, it would seem that the points raised should cause little, if any, consternation.

Looking at the problem, even from the viewpoint of the dissenting opinion, reproduction cost is a most important factor in the determination of the fair value of a telephone property for rate making.

In connection with the majority opinion, the court conveyed a broad and unmistakable hint to those of the public utility commissions who are inclined to assume an arbitrary and dictatorial attitude toward the administration of public service enterprise. This "hint" was made in connection with a discussion of the 4½ per cent which the subsidiary Bell company paid to the parent Bell company, the A. T. & T. Co. It suggests that while state commissions may **regulate** public utility companies for the purpose of en-

* Mr. McKay heads the organization of Charles W. McKay and Associates, Consulting Engineers, 646 North Michigan Avenue, Chicago.

A telephone personality

In your face to face contacts with people, your appearance, your bearing and many other things help you to make the right impression. But in your telephone contacts there is only one thing by which you can be judged—your speech.

An effective telephone personality is to-day a business and social asset. Everybody appreciates the person who speaks distinctly and pleasantly, neither too fast nor too slow, with a clear enunciation of each word, with lips facing the mouthpiece and speaking into it. In business, this is the telephone personality which induces favorable action on the part of the listener. To the salesman it may mean the difference between an order and no order; between an interview granted and an interview refused.

Curiously enough, people who are careful to make themselves effectively heard and understood face to face, often disregard the need for effectiveness in their telephone speech. Perhaps they shout, perhaps they mumble, perhaps they hold the mouthpiece far from their lips. And frequently they never realize that their carelessness has defeated the purpose of their talk.

The Bell System maintains for telephone users the best facilities that science, modern equipment, skilled operation and careful management can bring to telephone speech. But these facilities can be fully effective only when they are properly used.

"BELL SYSTEM"
AMERICAN TELEPHONE AND TELEGRAPH COMPANY
AND ASSOCIATED COMPANIES
One Policy, One System, Universal Service, and all directed toward Better Service

forcing reasonable rates and charges they, the commissions, **do not own the property** of public utility companies and are "not clothed with the general power of management, incident to ownership."

In connection with the foregoing discussion of the decision of the Supreme Court, a brief history of the case may be of interest. At the time Postmaster General Burleson turned over the administration of the Southwestern Bell Telephone Co., to its owners, the company applied to the Missouri Public Service Commission requesting permission for a continuance of the so-called Burleson rates in certain of its exchange areas. The Southwestern Bell Telephone Co. also asked the commission to permit the continuance of the service connection charge, as inaugurated by the Postmaster General. After a rather lengthy hearing, the commission denied the company's application and canceled the service connection charge. The company appealed the case to the State Supreme Court of Missouri. This court upheld the commission. An appeal was then made to the U. S. Supreme Court, and the decision discussed in this article was the result.

In the May installment of this series of articles, the subject of Collateral Costs was introduced and a certain group of costs (omissions, contingencies, purchasing expense, tool expense and so forth) which often are included with the Collateral Costs (though in reality they are more closely akin to items included in the appraisement of the inventoriable property) were discussed in some detail. In the July installment, we will continue our discussion of the Collateral Costs proper, these being the general and legal expense during construction; engineering and general supervision during construction; taxes and insurance during construction and interest during construction.

Missouri's Sixth District Meets at Sedalia

Sedalia, Mo.—Operating officials and operators of telephone companies in the sixth district of the Missouri Independent Telephone Assn., met here May 9. E. L. Chase, of the Kansas City Long Distance Telephone Co., spoke on "Public Relations." Other addresses were made by W. C. Polk, consulting engineer of the Gary Interests, on "Depreciation," and by Robt. Hedrick, secretary of the association, on legislative matters. The operators' school was conducted by J. P. Smallwood, Southwestern Bell's district traffic chief at Sedalia.

W. W. DEAN'S ACTIVE CARER ENDS

Veteran Independent Engineer and Inventor Dies Suddenly in New York

New York, N. Y.—William W. Dean, one of the most prolific inventors in the telephone industry, died of heart failure in New York, May 3. He was 60 years old. A widow, his sons, William W., jr., and Charles, and a sister, survive him.

Mr. Dean was born at Fairfield, Iowa. He attended Washington University at St. Louis, and after graduation became connected with the Missouri Bell company as troubleman, from which position he was promoted to chief inspector in 1887. After reorganizing and rebuilding the system of the Compania Union Telefonica at Buenos Aires, a job that kept him in South America for four years, he returned to the Bell, leaving the Bell interests to become chief engineer for the Kellogg Switchboard and Supply Co., where he remained for a number of years.

He also was connected with the Western Electric Co., and with the Stromberg-Carlson Telephone Mfg. Co., during the early part of his career. In 1908 he organized the Dean Electric Co. After several years in this connection, he returned to his electrical engineering practice.

Prior to his death Mr. Dean was with the United States Cartridge Co., at Lowell, Mass., designing phonograph motors, and was on his way to join the General Motors Research Co., at Dayton, O., when he died.

Mr. Dean was credited with the perfecting of automatic ringing, and the invention of a system of harmonic ringing which he developed as a manufacturer. His decided inventive genius had much to do with the advance of Independent telephony. He was widely known in the industry, and took a strenuous interest in its promotion. During the latter part of his life he was not actively engaged in telephone work, but retained his friendships in the industry. A few weeks prior to his death he was the guest of his long-time friend, J. B. Edwards, president of the Kellogg Switchboard and Supply Co.

High Costs Stop Building of New York Telephone Home

New York, N. Y.—Work on the $11,200,000 new home of the New York Telephone Co. has been suspended due to high building costs.

Medora, Ind.—O. V. Starr has sold the Medora telephone plant to E. S. Welsh, A. V. Ault and L. S. Shockley of Seymour.

W. S. Vivian Goes with Middle West Utilities Company

Chicago, Ill.—W. S. Vivian, formerly head of the Automatic Electric Co., department of Public Relations, has joined the Middle West Utilities Co. Mr. Vivian entered the telephone industry in 1899, with the old Michigan State Telephone Co. He has been active in the national Independent telephone organizations, and has been a prominent figure at state conventions for years past. As a captain in the Signal Corps he arranged for the care and disposition of the first groups of telephone operators sent to France. Mr. Vivian was one of the original members of the Illinois Committee on Public Utility Information, and retains his membership in this body, in his new work. He supervised the first operators' school ever held, and was to a large degree responsible for the growth and success of these schools.

First Meeting of Georgia Assn. Shows Promising Organization

Fitzgerald, Ga.—Another Independent state association made its debut at Fitzgerald, May 17, when the first annual convention of the Georgia Independent Telephone Assn. was held. W. R. Bowen, of Fitzgerald, is the association's first president. Other officers are: Vice Presidents, W. R. Hunter, Quitman; J. M. Dent, Douglas, and P. D. Fortune, Summerville; secretary-treasurer, J. L. Mathews, Statesboro; general counsel, J. Prince Webster, Atlanta. The program of the first meeting included "The Future of the Industry from an Independent Point of View," by W. R. Bowen; "What Co-operation and Organization May Accomplish," by J. Prince Webster; "Question Box," in charge of W. A. Jennings; "Public Relations and Standardization of Telephone Directories," by J. L. Mathews; "The Value of Systematic and Uniform Accounting," by W. G. Merrick; "Toll Line Development and Its Possibilities," by J. P. Manning; "Toll Terminal Charges or Exchange Compensation," by J. M. Dent, and "Depreciation Reserves to Be Prescribed by the Interstate Commerce Commission and Effects," by J. Prince Webster.

Up-State District Meetings Are Scheduled

Albany, N. Y.—J. G. Ihmsen, vice president and general manager of the Up-State Telephone Assn., announces meetings will be held at Vernon, June 22, and at Middleburg, June 29.

"Practically all the Pole Construction and Reconstruction is Limited to Creosoted Pine Poles —as we have found them more satisfactory from a number of standpoints."

from a large user of Poles

Here Are His Reasons:

The expected long life of creosoted pine poles makes the annual charges less than for any other type of pole.

The poles stand wind pressure much better than poles of other species. They do not break in wind storms and at the worst they may blow down.

Creosoted Pine Poles resist grass fires. The lessened number of interruptions to service is as important as the saving in replacement of burned poles.

These poles stand up much better during flood periods—and there is better assurance that these lines will give long, dependable service even under adverse weather conditions.

International Creosoted Pine Poles are straight, strong and durable. Let us quote on your requirements.

International Creosoted Pine Poles in line of Southwestern Bell Telephone Company between Hicks and Fort Worth, Texas. The poles are 40 foot, Class B poles, and average 52 per mile.

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Plants: Texarkana, Texas Beaumont, Texas
Galveston, Texas

India Is Going Automatic

Delhi, the Imperial Capital, Will Install Another Automatic System—Other Parts of India and Burma Already Are Equipped with North Apparatus from Galion, O.

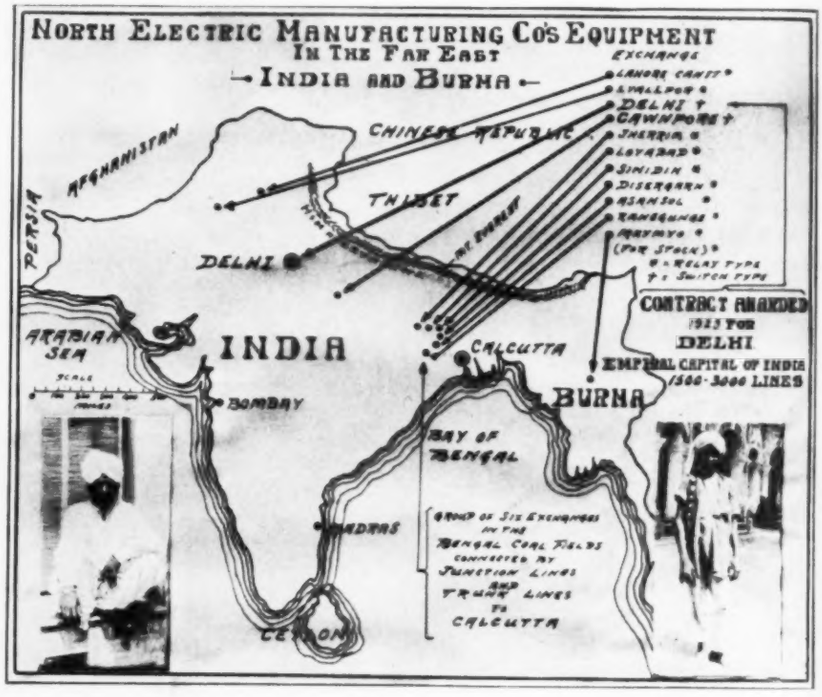
Delhi, India, March 1923.—The Telephone and Telegraph Department of the India government has decided to install an automatic telephone system at Delhi, the imperial capital of India. The exchange is to have a present equipment of 1,500 lines and an ultimate capacity of 3,000 lines. The order for the automatic equipment has been placed with The North Electric Manufacturing Co. of Galion, O., through their associated house in England, the Peel-Conner Telephone Works. This makes the twelfth automatic exchange equipment furnished by the North company for the India government within the last two years.

Delhi is a cosmopolitan city of over 300,000 inhabitants, situated on the river Jumna. The great transcontinental railroads pass through and have important terminals at Delhi, while the big project of linking up all the large cities with toll lines will make this city the long-distance center of India. The Great Mogul Emperors ever have made Delhi their capital and it has played an important role in the history of the Indian Empire.

The city may be divided into two distinct areas: one the ancient and commercial native city with its bazaar quarters, its teeming thousands of industrial workers, its world renowned industries of ivory carving and jewelry and its rug making, silks and works in marble; the other, the stately government city with its imposing administrative buildings, its big shops, modern hotels and European population. Here resides the Viceroy of India, the Military Governor, secretaries, senators, maharajahs and princes. While Parliament is sitting, its social life is comparable in elegance and splendor to that of the old world capitals.

Owing to the steady development of the country and increasing needs of the government for more accommodation, a New Delhi was conceived a few years ago on a most magnificent and majestic style, within a few miles of the present city. The project is estimated to cost one hundred and fifty million dollars. Automatic telephone equipment is to be installed in this new government area and, consequently, will handle all official business in India.

The equipment will be North dial controlled machine switching type, and will be especially treated in the same manner as their other tropical equipment, at present in use in various parts of India, so as to render the apparatus impervious to the deteriorating effects of the tropical climate. The exchange is to be cut over by the fall of 1924. The accompanying map of India and Burma shows the government telephone exchanges equipped with The North Electric Manufacturing Co.'s automatic system. It will be noticed that they spread almost entirely across the Indian Continent and way down into Burma. The Delhi and Cawnpore exchanges are both of the switch type; that is, selection is made by means of two-way switches, the apparatus and circuits being of the standard central office design. The Cawnpore exchange has a present equipment of 500 lines and a capacity of 2,000 lines.



Bengal coal fields have a present equipment of 1,000 local and junction lines and an ultimate capacity of 3,000. They are automatically connected with one another and the whole group has connection with Calcutta by means of toll lines from Asansol.

Wanted—Copies of TELEPHONE ENGINEER for February, March, April, May, and June, 1921. Will extend your subscription two months for each copy you send us. Address: TELEPHONE ENGINEER, 28 E. Jackson, Chicago, Ill.

These men made your telephone

British Indian. A swarthy miner of mica—insulation inside the telephone.

Brazilian. He drains rubber from a tree. Rubber forms the case of the receiver.

Japanese. Prepares the silk used in the covering on the telephone cord.

Irishman raises flax, from which is made linen paper — used in the condenser.

Russian. He mines the noble metal, platinum, used in your telephone.

Egyptian. We must go to the Nile Valley for certain cottons used to insulate wires.

Pennsylvanian coal miner. Grains of coal, inside the transmitter, are the vocal cords of your telephone.

Alaskan. Your telephone needs gold too, and here's the man who digs it.

—and the workman at Chicago

FROM a slab of rubber, a bundle of vegetable and animal fibres and a curious medley of minerals brought from every corner of the world, this man's skill produces a marvel of precision and ruggedness—your telephone.

He is one of 28,000 men and women at the Western Electric works in Chicago. As makers of telephones and the countless items of telephone apparatus, they are setting the standard for the whole world.

Amid strange scenes in strange lands, the picturesque types above are gathering some of the 19 materials needed to make your telephone.

Western Electric

Since 1869 Makers of Electrical Equipment

No. 2 of a series on raw materials.

Telephone Talks
No. 4

Life of Dry Cells

GETTING life from a dry cell is not the perplexing problem that the prisoner faces before a jury. However, the verdict one arrives at in determining the life's service to be expected from a dry cell might be just or unjust according to factors given consideration.

Surely no more important factor can be considered than the ability of the cell to remain inactive with least deterioration. Especially in telephone service is this true.

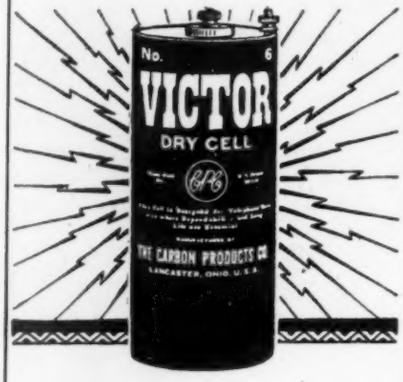
Victor Dry Cells show an extremely small and gradual curve of deterioration in shelf life. Special ingredients have been added to the mixture to offset as much as possible the slow chemical action that otherwise weakens the cell when idle.

The result is a surprisingly long drawn out shelf-life. The critical point of decline is noticeable long after other cells begin to drop sharply in amperage and voltage.

Victors maintain this service life more securely due to the extra reserve strength characterized by rapid recuperation after each closed-circuit period.

The higher voltage also plays a part.

Prove it to your own satisfaction.



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RADIO VIA TELEPHONE

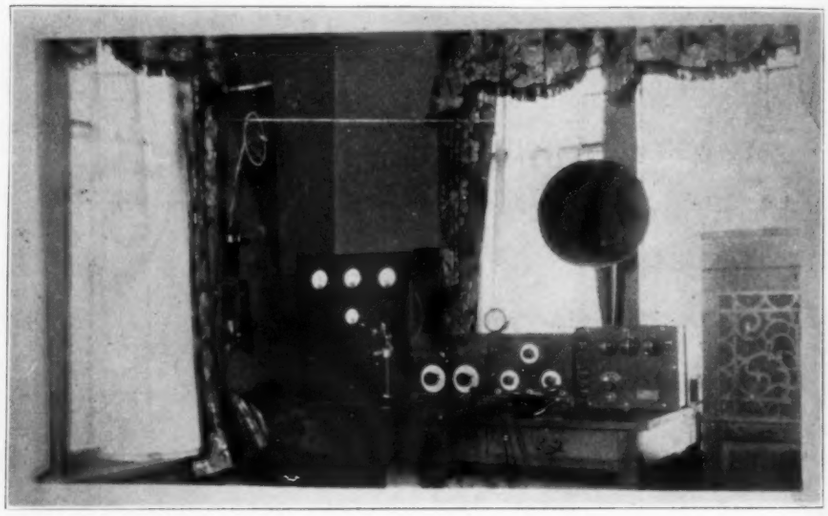
J. A. Gustfason, Fredonia, Kan., Manager Works Out Plan That Makes Good

Fredonia, Kan.—J. A. Gustfason, manager of the Fredonia Telephone Co. is showing what can be done by telephone companies in furnishing radio programs to the companies' subscribers. Kansas telephone men have watch Gustfason's pioneering with considerable interest, and the chances are that his method will be widely employed throughout the state.

Mr. Gustfason says of his service:

"As far as we know ours was the first company to give this class of service by use of loud speakers.

"Radio manufacturers and dealers do not like to see us furnish such service as they feel it will cut down the sale of radio sets. I am dealing in radio sets and I do not think it has lost me business.



Telephone companies furnish radio programmes to their subscribers in Kansas

"We have a receiving set and amplifiers in our telephone building and, by the use of pairs in our cables, we connect loud speakers in homes and business houses direct to our amplifiers. When we tune in to a broadcasting station all loud speakers, being direct connected, receive what we get. These loud speakers must be balanced up on the lines in such manner as to secure the best results from the amplifiers. This service has no connection with the individual telephone lines.

"We make no charge for the radio programs received, and we have placed a connection on our switchboard so that any telephone subscriber can tell central and be connected and listen on their telephone. Where they have loud speakers we charge a monthly rental for the cable pair used. This is the class of service desired. Having the opportunity to listen in on their telephones creates a desire for the loud speaker service in order to give the family a chance to hear.

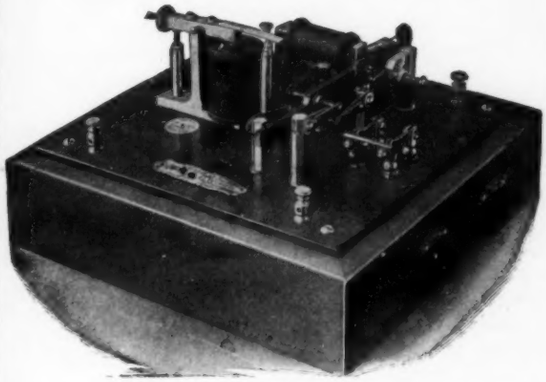
"There are 66 stations connected to our amplifiers at present. We have not solicited, and have turned down, a hundred applications because of lack of cable pairs in certain parts of the city.

"I read the article in April TELEPHONE ENGINEER by Mr. Rathbun. It was very interesting and no doubt would work, but I can not see the demand for this class of service. The public does not want crystal sets and headphones, or to have to tune in if they are going to pay for the service. If they have to buy a set in order to tune in by wired wireless they will turn down such service and tune in direct with a set of their own. This service can not be sold to the public unless it will be such as to operate a loud speaker.

"Such service as we are giving could be made valuable to the subscriber. The business could be built up to provide sufficient revenue to enable a company to put on a very interesting local program when there was nothing being received from distant broadcasting stations. All the equipment required would be a good microphone connected to the amplifiers. The latest news items and a musical program could be furnished during the meal hours. Two or three good lectures could be broadcasted each week. The owner of such system could command from business men a fair price for an advertising talk. In fact such a system could be made a great source of entertainment.

"If the public was certain of receiving a service whereby they could sit by their own fireside in an easy chair and listen to concerts, lectures and sermons at a small monthly charge, and without effort on their part, no doubt this service would sell as well as the

Warner Pole Changer



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—the kind of service that is satisfying 25,000 users. Isn't this what you want?

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Time and the aid of America's foremost engineers, have enabled us to develop and manufacture the highest grade wire known to the trade. It is greatest in conductivity and lasting qualities, due to the superior quality of material from which it is made, as well as its *Extra Double Galvanizing*, which insures longest life.

STEEL STRAND

Single and Double Galvanized, Standard, Siemens-Martin, High Strength and Extra High Strength Grades.

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Telephone companies of every size are using EVERSTICK Anchors because they are the best value in the world for holding hard and fast and for ease of installation.

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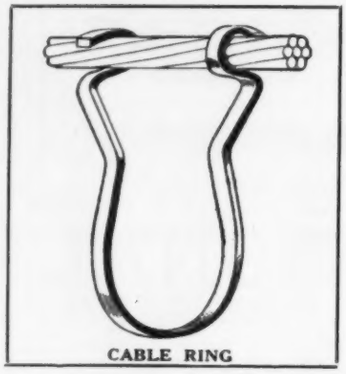

CABLE RING

Telephone Construction Specialties mean specialized study of construction needs . . . research devoted to improving conditions of labor and increasing the efficiency of telephone lines.

TELEPHONE

Supplies have unquestionably shown a vast improvement over what the telephone companies were obliged to use in past years, yet even today, where there is a *better* product there must also be a *best*—a matter of economical consideration for the man who buys.

National Telephone Supplies' claim to recognition is on the strength of the esteem with which they are universally held * * * by men who must keep their fingers on the pulse of cost systems, and by those whose duties call for the rugged work of actually doing the job and doing it correctly and quickly.

Take, National Cable Rings for example. Here is a simple device * * * so simple in construction that it takes but a moment to put up, grips the messenger with amazing force and is particularly liked because of the ample space for reclipping.

National Double Tube Sleeves when twisted practically form a welded joint. One that is absolutely air-tight, long lasting, *sure of itself.*

Other NATIONAL TELEPHONE

Construction Specialties

Single Tube Connectors

C-B Knobs

Marline Hangers

Non-Breakable Messenger Hangers

THE NATIONAL TELEPHONE SUPPLY CO.

5100 Superior Ave., Cleveland, Ohio

telephone. With entertainments furnished from a local station by amplifiers and loud speakers it would be free from static and interference.

"We have loud speakers in homes where there is no telephone. If good service could be furnished people would subscribe to it even if they already had receiving sets."

LIST OF RADIO BOOKS

Elementary—

Radio for All, by H. Gernsback, 300 pp., 130 illustrations, The Experimenter Publishing Co., N. Y. Price $2.00.

Elements of Radio Telephony, by W. C. Ballard, Jr., Second Edition, 150 pp. McGraw Hill Book Co., N. Y. Price $1.50.

There are many other books of widely varying excellence in this class.

Intermediate—

Radio Telephony for Amateurs, by Stuart Ballantine, Second Edition, 296 pp. Price $2.00.

The Principles Underlying Radio Communication, U. S. Signal Corps Radio Communication Pamphlet No. 40, Second Edition, Superintendent of Documents, Government Printing Office, Washington, D. C. Price $1.00.

Advanced—

Principles of Radio Communication, J. H. Morecroft, John Wiley and Sons, N. Y., 935 pp. Price $7.50.

The Thermionic Vacuum Tube, by H. J. Vander Bijl, McGraw Hill Book Co., N. Y., 391 pp. Price $5.00.

Electric Waves and Electric Oscillations, by G. W. Pierce, McGraw-Hill Book Co., 515 pp. Price $5.00.

Purdue Honors J. G. Crane

J. G. Crane, Vice-President and General Manager of the Kansas City Telephone Co., received the advanced degree of Electrical Engineer from his alma mater, Purdue University, June 13. Mr. Crane was graduated from Purdue in 1903 and has been actively engaged in the telephone business since that time. The present degree is granted in recognition of his work in the telephone field. For several years after graduation, Mr. Crane was engaged in the manufacturing end of the business with the Western Electric Co. He later went into the operating field and for the last eight years has been located in Kansas City, first as Plant Superintendent and later in his present position as operating head of the Gary properties. In his capacity as General Manager, he supervised the unification of the two competing systems of Greater Kansas City, which is the largest unification problem that has been attempted in the telephone industry.

REPRODUCTION VALUE

U. S. Supreme Court, in Case of Southwestern Bell vs. Missouri Commission

Washington, D. C.—The United States Supreme Court in the case of the Southwestern Bell Telephone Co. vs. the Missouri Public Service Commission, has decided that the state, in telephone rate making, must consider the present cost of reproducing the telephone company's property.

The majority opinion, from which Justices Brandeis and Holmes dissented, said: "It is impossible to ascertain what will amount to a fair return upon properties devoted to public service without giving consideration to the cost of labor, supplies, etc., at the time the investigation is made. An honest and intelligent forecast of probable future values, made upon a view of all the relevant circumstances, is essential."

"If the highly important element of present costs is wholly disregarded, such a forecast becomes impossible. Estimates for tomorrow cannot ignore prices of today."

"It must never be forgotten," the court said, in discussing the 4½ per cent paid to the American T. & T. Co., "that while the state may regulate with a view to enforcing reasonable rates and charges, it is not the owner of the property of public utility companies and is not clothed with the general power of management incident to ownership."

Advocates of reproduction cost as an element of rate making would find its application harmful to the public utilities when the cost of materials and wages were lower, said Justice Brandeis, in suggesting as a preferable basis the money invested in the enterprise. Urging the court to "lay down a rule which will establish such a rate basis and such a measure of the rate of return deemed fair," he criticized his colleagues for leaving many of the elements to be determined by the opinion of experts, instead of making rates dependent upon ascertainable facts.

While contending that reproduction costs as an essential element in rate making are better than the old tests, selling price or net earnings, the minority insisted that "where the financing has been proper, the cost to the utility of the capital required to construct, equip and operate its plant should measure the rate of return which the constitution guarantees opportunity to earn." Such a rule, it added, would make rates based on facts and not on opinion.

Under the rule which the court adopted, the value for rate making purposes, the minority insisted, "must ever be an unstable factor."

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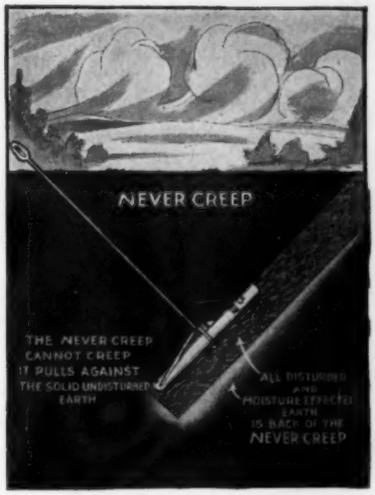
NEVER CREEP
THE NEVER CREEP CANNOT CREEP IT PULLS AGAINST THE SOLID UNDISTURBED EARTH
ALL DISTURBED AND MOISTURE EFFECTED EARTH IS BACK OF THE NEVER CREEP

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"It's in solid"

No "pull" can make this anchor waver a bit in its fidelity to your interests.

It has a heart of iron, it is strong and long-lived.

It stays where you want it to stay, and goes there without any great expense.

It's the only anchor with the Thimbleye—the improvement that preserves the guy wire and makes installation easy.

This space won't permit the whole story but our booklet does—want it?

This is the Never-Creep's Patented Thimbleye that makes the guy wire's life longer, and installation easier.

CHANCE COMPANY

Anchors, Socket Wrenches, Protectors, Brackets, Back Trusses

CENTRALIA, MO.

Negotiations at Louisville

Philip S. Pogue, president of the Home Telephone Co. at Louisville, Ky., declines to discuss any phase of the proposed consolidation with the Cumberland Telephone Co., saying he and Louis K. Webb, manager of the Cumberland, have agreed to leave all publicity in the matter to Mayor Quin. The Home company has declined to sell unless all of its subsidiary companies in Kentucky and southern Indiana are included. While the Home is willing to sell, it has nothing to gain from it, and will demand its price, which is understood to be over $5,000,000. The Home is on a paying basis, while the Cumberland is just getting on its feet. The latter has 11,000 stations in Louisville, compared to the Home's 29,000.

Athens, Tenn.—Mrs. Marvin Bates, for five years with the Southern Bell Telephone Co. at Albany-Decatur, Ala., has been made Athens manager for that company.

Germany Is Developing

Germany is allowing nothing to stand in the way of development of its telephone system, while other countries of Europe are getting along with inadequate communication service, lacking sufficient equipment and the budgets required for expansion, declares H. Fleetwood Albright, vice president of the Western Electric Co. in charge of the Hawthorne Works, who returned to Chicago recently after a two months' trip abroad. Germany, he says, is not finding it difficult to obtain money to put into telephone and other internal developments, despite its pleas of poverty and inability to make reparation payments to the allies.

Upshur Telephone Co.

The Upshur Telephone Co. of Buckhannon, W. Va., has been incorporated with a capital of $5,000. Incorporators, E. M. Anderson, Minnie Anderson, Floyd Kesling, W. O. Hinkle, Alpha Hinkle, all of Buckhannon.

POSITION WANTED: First-class cable-splicer, thoroughly experienced on clearing all kinds of trouble and installing new systems. Prefer permanent, but will consider temporary, position. Ten years' experience. Go anywhere. Address: L. V. Longenecker, Box 199, Hamilton, Ill.

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Rebuilt and Good as New
Complete Line of Telephone Equipment Thoroughly Overhauled by Honest Experts In This Business, In Chicago, Over 15 Years.
Write for Latest List of Guaranteed Bargains.
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CHEAPER than typewriter—SAVES 20% of YOUR present costs — 5 to 15 times FASTER and BETTER than pen or typewriter.
FREE TRIAL will prove it!
Easy Pay't. Terms
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PEERLESS Automatic Water Stills
Absolutely pure water for less than one or two cents a gallon, no matter how polluted your supply of water may be. For drinking, chemical or battery purposes the Peerless stills give you the best, ample supply at lowest cost.
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